DOCUMENT RESUME

ED 197 214 CE 027 898

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TITLE Access to Vocational Education. A Planning System for Local Secondary and Post-Secondary Program and Facility Accessibility. Step 4: Selecting Strategies.
INSTITUTION Barrier Free Environments, Inc., Raleigh, N.C.: System Sciences, Inc., Chapel Hill, N.C.
SPONS AGENCY Office of Vocational and Adult Education (ED), Washington, D.C.
PUB DATE [80]
CONTRACT 300-78-0592
NOTE 66p.: Photographs and green headings will not reproduce well. For related documents see CE 027 894-901.

EDRS PRICE MF01/PC03 Plus Postage.
DESCRIPTORS *Accessibility (for Disabled): *Access to Education: Administrator Guides: Change Strategies: Cost Effectiveness: *Costs: Decision Making: *Educational Finance: Educational Planning: Equal Education: Evaluation Methods: Guidelines: Needs Assessment: Postsecondary Education: Programed Instructional Materials: School District Spending: Secondary Education: Selection: Systems Approach: *Vocational Education

ABSTRACT

This guidebook focuses on the fourth of five steps included in a planning system for improving local secondary and postsecondary program and facilities accessibility: strategy selection. The first of five major sections included in the guide gives an overview of costs associated with providing education for handicapped students, discusses thirteen varieties of cost, and describes variables that can affect costs in educational settings. Section 2 focuses on decision matrices which allow judgements to be quantified for ease in choosing among alternatives. Specific topics addressed in section 2 include strengths and limitations of decision matrices, when to use decision matrices, materials and resources required, and how to implement a decision matrix. Focusing on cost benefit analysis and cost effectiveness analysis, the fourth section addresses how to determine the optimum allocation of resources in comparing alternate strategies for barrier removal. The final two sections of the guide describe the use of decision trees and simulations in strategy selection. The booklet contains self-instruction exercises. (LRA)

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Access to Vocational Education

A Planning System for Local Secondary and Post-Secondary Program and Facility Accessibility

ED197214

Step 4

Selecting Strategies

U S DEPARTMENT OF HEALTH, EDUCATION & WELFARE
NATIONAL INSTITUTE OF EDUCATION

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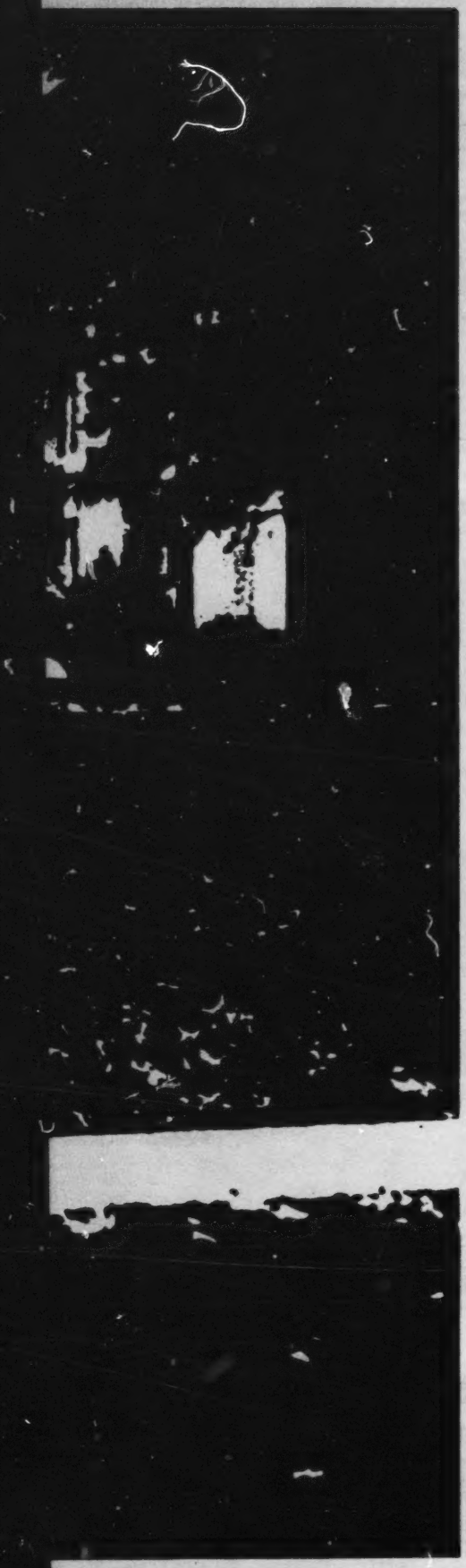
Step 4: Selecting Strategies

Costs, 5
Decision Matrices, 19
Cost Benefit-Cost Effective Analysis, 27
Decision Trees, 47
Simulation, 53

Information Estimating Costs and Suggested Techniques for Comparing Alternative Strategies

1



Introduction

The fourth step of the Planning System is strategy selection. This is the process that will permit you or the Local Planning Committee of your educational unit to compare systematically and choose among the alternative strategies generated in Step 3 of the Planning System. Recommended comparison processes can be used by a single administrator or by a group of planners. It is suggested that if comparison is performed by a single person, then confirmation, explanation and final selection of a strategy or group of strategies should be completed conjointly with the Local Planning Committee.

How to Use This Booklet

The purpose of this booklet is to assist you and the LPC of your educational unit to compare the alternative strategies generated for removing barriers and to select the strategy that best meets the needs of your educational unit. The booklet contains several sets of materials including a discussion of costs associated with accessible programming and self instructional materials that present each of four recommended techniques for comparing alternative strategies for removing barriers.

Before opening this booklet on Selecting Strategies, you have noted on the Planning Record the name of the procedures you believe to be most useful in your setting for comparing strategies. Please read the material on costs; then turn to the comparison technique entered on your Planning Record and read the materials. Note that the materials assume that you will be directing the planning exercise. If you have delegated this responsibility to someone else, this booklet should be studied by that person. After you have completed the reading, you must consider again your choice of procedures and make a final decision about which technique you will use.

Costs

OVERVIEW OF COSTS ASSOCIATED WITH PROVIDING EDUCATION FOR HANDICAPPED STUDENTS

During the pre-1950's era, only those handicapped students who presented major instructional problems received attention in the schools. They were segregated into separate classes and assigned to a teacher who often was rewarded with a special supplement. If the teacher was fortunate, class size was reduced and special materials were provided. The "cost" of special education was figured on a per-pupil basis by incorporating teacher supplement, class size and special materials provided.

From the 1950's through the 1970's educational concepts about handicapped students and their treatment in the school system changed. Programming for handicapped students became more "individualized" and disabled students were increasingly integrated into the regular classroom. With the increased attention to individual needs came a shift from the one-teacher-per-classroom concept to individualized and varied programming to meet specific needs. Diagnosis by a team is now common along with a full complement of support staff.

Unfortunately, methods of collecting cost data for programs for special needs students have failed to keep pace with the change in programming. As Singletary (1976) observed:

> It quickly becomes apparent to an investigator dealing with exceptional child programs that there is a paucity of information concerning the financing of such programs. (p. 334)

One of the pioneers in the area of program-cost differentials of exceptional versus regular students was Bentley (1970). In sampling 16 exemplary programs, he identified eight categories of costs that contributed significantly to programming for exceptional students. When ranked from high to low in order of degree of consistency across educational units, these categories of cost included: teachers, support services, instructional supplies and equipment, operation and maintenance, program administration, fringe benefits, teachers' aides, and transportation. Teacher and instructional-staff salaries were the most expensive items in the school budgets. Other studies have confirmed the relative expense of teacher salaries; approximately 75%-80% of a typical school's operating budget is allocated for salaries (Rossmiller and Geske, 1976).

The National Education Finance Project, completed in 1970, attempted to develop a program-cost differential methodology and encountered difficulties in efforts to identify costs relating to special students because pupil, personnel and fiscal accounting records were not maintained on a program basis (Rossmiller, Hale and Frohreich, 1970). In fact, the literature in the area of school finance and costing rarely treats programming as a fiscal issue (Bernstein, Hartman, and Marshall, 1976).

This is particularly unfortunate since programming is one of the most critical variables affecting the cost of serving handicapped persons (Bernstein, *et al.*, 1976). Data about

type of handicap are apt to provide little insight about true cost. Individuals vary so widely within categories of handicap that effective programming cannot be based on this factor alone. A severely physically handicapped student may require residential care whereas a student with partially restricted mobility may be capable of functioning well in the regular classroom.

In addition to the problem of lack of data by program, many states have a more basic deficiency in costing in that necessary data in any form are often totally absent. A recent national survey of vocational education revealed that only 12 states have adequate cost data necessary for program planning (Hale, 1978). Data that do exist are often descriptive rather than normative, usually meaning that past rather than current costs are available, which typically does not reflect current need. It is common to find data in aggregated form which then must be manipulated and converted. Further, qualitative variables such as efficiency and feasibility are usually absent and therefore not systematically taken into account (Bernstein, *et al.*, 1976).

Other problems relate to accounting practices and difficulties inherent in the manner in which financial records are maintained. As stated earlier, accounting records are not always maintained on a program basis. Accounting practices seem to vary from simple line-item to extensive computerized program accounting. This variability is, in itself, a problem in that one district may not be able to obtain usable cost data from another district which may have used a strategy under consideration because of differences in the way financial records are maintained (Singletary, 1976).

VARIETIES OF COST

Although cost is a seemingly precise quantitative term, it is more subjective than most people realize. It is important that the subjectivity of its conceptualization, computation and analysis be understood so that an eduational administrator can make decisions on the basis of cost data and convey cost information simply and accurately. For you as administrator, cost is a conceptual organizer, a tool for ordering large amounts of divergent information in usable, comprehensible form. When appropriately analyzed and presented, cost is also a means of communicating with others as a language of precision, once its dimensions are defined.

In its most meaningful form, cost is more than expenses expressed in dollars. Costs also must be conceived as time and energy expended, pain and discomfort endured, and alternatives foregone. When possible, it is helpful to express costs in dollars since this is a common medium of exchange and most easily communicated and understood. This is not to imply that the only meaningful kind of cost data is that expressed in monetary terms, for there are many categories of qualitative data that cannot be reduced meaningfully to dollar figures. These kinds of data do not necessarily create problems in conceptualizing and figuring costs unless they are dismissed as "non-cost considerations." Qualitative costs are not less significant because of their nonquantitative nature; however, they must be handled in a different manner. Some data actually lose meaning when artificially forced into a quantitative framework. Consider, for example, the cost of a human life. Clearly the cost is more than foregone income figures in lifetime earning potential. The art of cost analysis lies in identifying key costs and knowing what qualitative data to leave in qualitative form.

Cost is best thought of as a conceptual _____ for ordering large amounts of divergent information in usable form.

Costs deal with quantitative and qualitative data. (True or False).

Answer: organizer; true.

There are several varieties of cost that you as an educational administrator will encounter in making strategy comparisons and resource-allocation decisions. The following list of cost categories is by no means exhaustive. It is rather a representation of the broad, categorical units into which costs are commonly organized. There are more specific costing terms used in an accounting sense that are beyond the scope of this discussion. Since accounting systems vary among educational units, any discussion around the topic would likely be inapplicable to most readers. Administrators are referred to *Financial Accounting: Classifications and Standard Terminology for Local and State School Systems, Handbook II* (Revised), (USOE, 1973) and other materials in *State Educational Records and Reports Series.* Most educational units use some variation of the format and terminology suggested in these documents.

1:Opportunity Costs. When resources are used in a particular way, there is a cost involved in foregoing other ways of using the resources. Opportunity costs often are computed in terms of the maximum value of the next best alternative use of the resources in question. It is unnecessary to include all possible opportunity costs; only those relevant to the strategy under consideration need be computed. It is especially useful to consider opportunity costs when the supply of inputs (resources) is limited. If you find, for example, that an alternative program has more value than one presently in operation, you may decide that the opportunity costs of the program in operation are too great to justify its continuation. The next logical decision to make would be to put into operation the alternative program with greater value for the same expenditure of resources.

There are circumstances where opportunity costs may equal zero. Consider the situation where an abandoned school building is to be used for a particular program. If there were no alternative uses for the building, the opportunity costs in using the building for the program would be zero. Such a situation does not frequently occur, however. As resources become increasingly scarce, it will become more critical to figure the opportunity costs of expenditures.

2: Relevant and Irrelevant Costs. Those costs that are relevant depend on the decision to be made. If the decision is a choice between two instructional strategies, both of which are appropriate for classroom use only, then pupil-transportation costs are irrelevant. Not all kinds of costs are this clear-cut, however. You must exercise skill in defining the boundaries of the decision under consideration.

3: Past and Future Costs. Future costs are those costs that will be incurred as a result of the decision to be made and are therefore relevant costs. Generally, past costs are irrevelant. Past costs have been incurred and do not accurately reflect true costs. Consider, for example, the costs of a resource room strategy in the high school. Past, and therefore irrelevant, costs include the costs of the building, utilities, previously purchased materials and equipment that were used for other purposes, and counseling time if students would spend the same amount of time in counseling regardless of the program. These are often referred to as "sunk" costs since they are not affected by the decision under consideration.

Past costs are not always irrelevant. If past costs are a true or accurate projection of future costs, then past costs would be relevant. Given current and projected future rates of inflation, it is likely that most past costs would be relevant only for use as a base for making adjustments. Future projected interest rates, inflation increases and changes in market supply as they affect demand and price are relevant pieces of information not revealed by past costs.

4: Direct and Indirect Costs. Direct costs are those costs that can be directly allocated and obviously linked to a particular strategy. Examples of this type of cost typically include salaries, employee benefits, supplies, materials, purchased services and all other items directly related to the strategy under consideration. Indirect costs are those costs which cannot be tied to a single specific strategy. Examples include instructional-support costs such as student counseling, health and psychological services, media, curriculum development and staff training. Also included in this category

are general-support costs from other departments as well as depreciation and employee benefits.

5: Fixed and Variable Costs. This dimension of cost depends upon the degree of variability of the cost in relation to the strategy under consideration. Fixed costs usually do not vary with the decision to be made. They are independent of the scope and volume of the proposed alternative strategies. Staff time and supplies may be considered variable costs if they change or vary as a result of proposed strategies.

Some analysts further refine the dimension of fixed and variable costs by including the dimension of semifixed and semivariable costs (Cleverly, 1978). These costs change according to changes in strategy results but the changes are not proportional. For example, utility costs may be fixed to a point but then vary as program volume increases. Semifixed/semivariable costs may be categorized as fixed or variable depending on boundaries such as time required or number of students served for the alternative strategies under consideration. Relevant dimensions to consider in determining whether costs are fixed or variable are time period and range or volume of activity. Costs may be fixed or variable depending on the size and resulting relevance of these two variables.

6: Recurring and Nonrecurring Costs. If the administrator is considering extending a program or strategy for a period of time, recurring costs will become the relevant figure. For example, one usually might exclude equipment costs from consideration in costing various strategies since it was purchased prior to strategy consideration and does not have to be replaced on a regular basis. However, costs for equipment maintenance and repair should be considered relevant costs, especially if the program is to continue for a period of time.

Please match the types of cost with the appropriate example.

Cost	Examples
1. ____ maintenance costs	a. recurring costs
2. ____ opportunity costs	b. building costs for current facility
3. ____ past costs	c. foregoing other uses of resources

Answer: 1-a; 2-c; 3-b.

7: External and Internal Costs. Costs that fall outside the realm of the strategies under consideration are classified as external costs whereas those that fall within are termed internal costs. It is necessary to look beyond the specific activities for costs. There may be costs that other departments incur as a result of the strategy implementation that are real and relevant costs. For example, if counselors are called upon to administer extra tests or commit extra time in some way as a direct result of a particular strategy implementation, these costs, although external, are nonetheless relevant.

8: Marginal Costs. Cost incurred as a result of marginal changes in an overall program due to strategy implementation are called marginal costs. Once a program or strategy is operational, it is often useful to identify the cost of adding one more student, one more unit of instruction, or one more instructional objective. Marginal costs typically relate to the volume or scale dimensions of the proposed activity.

This dimension becomes especially critical when the addition of an extra unit creates a need for significant program expansion and modifications. Consider, for example, the importance of marginal costs when computing the cost of adding one more sight-restricted student to a full-to-capacity woodworking course. Marginal costs could include costs for extra special equipment, space, materials, or instructional time.

9: Development "Start Up" Costs. This category of costs relates to the costs of establishing the technical expertise, space, facilities and so forth to carry out the strategy implementation within the overall vocational program. Included in this category may be activity costs of various pieces of the overall barrier removal strategy including such items

as in-service training for staff, workshops, labs, time spent in materials revision, and equipment and space modifications. Development costs are often ignored in figuring new program costs. This can be a disastrous oversight since these costs are sometimes extensive. It is also important to consider that development costs are nonrecurring or one-time costs and do not contribute to program costs once the program is in operation.

10: Operating Costs. These are costs that are incurred in using the strategy or keeping it in operation, a measure of internal resources consumed. Utilities, supplies, salaries, and so forth may be considered operating costs. They are relevant and recurring costs but are separate and distinct from the development costs of starting up an activity. Operating costs for transportation may include administration, labor, benefits, bus operation, transportation contracts, rent, as well as indirect or general overhead costs.

11: Total Costs. This category generally includes more than a dollar sum of costs; it includes non-dollar costs as well. In figuring total costs, it is important to avoid double-counting. For example, if materials are purchased for a particular instructiona strategy, materials costs are direct and relevant costs. If these same materials also are used by the counselor in working with students in the program, these materials are not again costed in the counseling component of the program although the portion of the counselor's time spent with the program may be included and is not considered double-counting. Other factors to consider in total costs may include disruption of routine caused by the strategy implementation, staff resistance, and administrative reorganization. These are costs that are difficult to express quantitatively yet are relevant cost considerations in comparing and selecting among alternative strategies.

12: Average Costs. Average costs are computed by dividing total costs by the total units of results from strategy implementation. Many authorities in the area of cost analysis suggest that average costs not be used for decision-making purposes since they mask important differences. Much more valuable to the decision-maker are marginal costs and other disaggregated costs.

In looking at strategies that may differ in effectiveness, it is helpful to look at average cost per unit of effectiveness because it provides a means of comparing diverse strategies. It is recommended, however, that the scale of the strategy be taken into account when using average cost. A program intended to serve a small number of students will show a completely different average cost than the same program costed on a regional scale.

13: Social Costs. Included in this category are all those conceivable costs viewed from a societal perspective. They may include the costs of donated time, goods and services as well as the impact on staff, students, the community, the environment or society at large. They are intangible and difficult to compute and therefore are often ignored. As mentioned earlier in this booklet, qualitative costs are not less significant because of their qualitative nature. In fact, one important social cost dimension, political cost, is so significant that it often outweighs all quantitative cost considerations, even in the most rigorous and complete cost-effectiveness study.

Please match the types of cost with the appropriate example.

Costs	Example
1. _____ average costs	a. administrative inconvenience
2. _____ social costs	b. costs of establishing technical expertise
3. _____ "start-up" costs	c. cost per unit of result

Answers:
1-c; 2-a; 3-b.

VARIABLES AFFECTING COST

There are a number of variables that affect cost. Some of the most important of these variables are discussed in the following sections.

1: Programming. The basic strategy under consideration is one of the most significant variables influencing the cost of educating handicapped students. The program-cost components identified by Bentley (1970) include: teachers, support services, instructional supplies and equipment, operation and maintenance, program administration, fringe benefits, teacher aides, and transportation.

There are several programming options for serving handicapped students. These are generally related to the severity of handicapping conditions and the degree to which the handicapped student is educated with nonhandicapped peers. These options may include:

- Regular classroom with support services
- Part-time Resource classroom
- Full-time Special Class
- Special School
- Residential

It should be noted that cost tends to increase the more severe the handicapping condition and the more specialized the program option used.

Franklin and Sparkman (1978) conducted a cost-effectiveness study of special class versus resource room placement using a matched sample of 64 elementary school students. The effectiveness measure consisted of gains on the Wide Range Achievement Test (WRAT) over a one-year period. Costs were analyzed according to (1) direct costs or those costs which could be easily associated with an activity such as salaries, employee benefits, purchased services, and materials and supplies; (2) indirect cost/instructional support or those services not directly associated with objectives but which nevertheless contribute to their accomplishment such as pupil services like attendance, social work, guidance, health and psychological services or support services such as in-service training, program supervision, curriculum coordination; and (3) general support services, indirect costs incurred through operation and school system management such as expenditures associated with the board of education, superintendent's office, business office, central services and the principal's office. Equipment and capital outlay were also computed and valued at current replacement cost, a more meaningful figure than original purchase price. Resource room costs were calculated on a per pupil basis whereas special classroom costs consisted of the maximum budget per pupil for the 1976-77 school year.

The results of this study indicated that the resource room was a more cost-effective placement than the self-contained special classroom. The mean per pupil cost in the resource room was about $1,312 compared to $2,830 for the self-contained classroom. Mean per pupil gains in achievement were greater in the self-contained special classroom than in the resource room; however, the difference was not significant and not large enough to outweigh the larger effectiveness-cost ratio of the resource room. This study illustrates an economic rationale for mainstreaming. As Franklin and Sparkman (1978) summarize:

> In terms of this investigation the least restrictive environment also means the least expensive environment with no difference in achievement gain. (p. 314)

This is not to imply that mainstreaming will be inexpensive or even cost-effective in the short run. It is important that the administrator be able to separate start-up/developmental costs from the more far-reaching and recurrent operating costs.

2: Transportation. Some program alternatives can involve significant transportation costs. Regional programs may save significant capital outlay costs but transportation costs may be great, depending on the distance students must be transported. Some students may spend two or more hours per day in travel time to and from regional facilities. Putting that time to good use, some systems are equipping buses with staff persons who cover curriculum units en route. This has the effect of lowering the total cost of strategy implementation. In addition to transportation to regional centers, other program alternatives such as homebound and hospital instruction involve staff transportation costs. Costs of special materials and supplies as well as staff time are involved.

Because transportation services are expanding so rapidly, costs in this area are spiraling. Nationally, transportation costs in 1977 were about $900 million (Bernd, Dickey and Jordan, 1976). Variables such as number of pupils, number of handicapped pupils, sparcity of population and road conditions have been employed as components of transportation costs. Some states have developed and used a weighted formula to calculate costs for transporting regular, special and vocational students. In one midwestern state, these were $110.63, $912.91, and $149.02 respectively for the 1976-1977 school year.

Extensive modifications will have to be made in transportation operations to serve some physically handicapped students, teachers and staff since some handicapped persons are more expensive to transport than regular students. Special lifts, ramps and seating arrangements will have to be constructed to accommodate these students unless an alternative to bus transportation is devised. A recent study estimated an average annual cost of transporting a physically handicapped student to be $2,200 while the average cost of transporting other special students was about $335 per student (McKeown, 1978).

The rapidly rising cost of fuel plus other inflationary variables will contribute significantly to transportation costs in the years ahead, a fact that antiquates cost estimates from previous studies. Researchers have been encouraged that transportation costs can be contained where possible by inter-district sharing and contractual arrangements as well as by the creative and imaginative use of transportation time for instructional purposes. Other suggestions include limiting the number of stops, using one bus for two routes, and using one large bus instead of two smaller ones for the same route (Johns and Morphet, 1975).

Some transportation costs are sometimes overlooked but nevertheless contribute to total costs. Some students may require special trips for diagnostic evaluation and treatment; additionally, aides may be needed to provide assistance. Field trips and certain types of vocational training, cooperative-education programs for example, also may entail transportation costs (McLure, 1975).

List two types of strategies that have been suggested as ways to contain spiraling transportation costs.

1. _____

2. _____

Answers:
Interdistrict sharing; use of time for instruction; reduce number of stops; use same bus for multiple routes; contract for transportation; adjustment of vehicle size.

3: Equipment and Facilities. Equipment costs for special education students are substantially greater than those for regular students. Bentley (1970) found that instructional supplies and equipment were two of the most important variables in accounting for differential costs of special education. Frohreich (1975) estimated that approximately 10%-15% of the capital outlay expenditures are for equipment, with variation depending on program type, grade level, and local economic conditions. The need for adequate, up-to-date equipment in vocational education is difficult to dispute. Considering the cost of retraining students who were trained on outdated equipment and the cost to society of an ill-prepared work force, it is not difficult to accept that expenditures for equipment in vocational programs is a cost-effective measure (Frohreich, 1975).

These costs are especially burdensome to schools in view of the fact that states rarely provide support for capital outlays. It is critical that these costs be adequately documented lest the total costs of educational programming for the handicapped be understated. This documentation should also include allowances for equipment modification for the handicapped, compliance with OSHA regulations, and regular equipment maintenance.

Another special concern in light of the accessibility legislation is capital costs. McLure (1975) identified four categories of programming related to capital costs: residential facility; regional facility to which students are transported; facility integrated with regular (including ramps, elevators, special rooms and equipment, self-contained classrooms and resource rooms); and building renovations and additions.

As several analysts have noted, it is considerably less expensive to make accessibility modifications during construction than to add them later in the form of renovations or additions. A 1978 estimate by the National School Boards Association for architectural-barrier removal was $1.7 billion total cost nationally, with an average cost of about $17,374 per building (NSBA, 1978). It is probably not possible to develop formulas for estimating capital costs since there are so many factors involved. Costs will vary by number of students served, differing student needs and the multiple functions which the facility will serve.

Since provisions for Federal financial assistance for renovation was authorized but never appropriated, educational units are understandably concerned. According to Section 504 of the Rehabilitation Act, any school system not in compliance with program accessibility requirements by June 4, 1980, is subject to withdrawal of Federal funds. Educational units are looking to other funding sources such as bond issues and tax increases. Other units are attempting to devise creative methods of making programs accessible, such as flexible scheduling and pooling of resources across school districts to establish regional facilities. A key phrase in the legislation is "program accessibility" as opposed to building accessibility. The legislative intent is not that schools make every room in every building accessible; only programs must be accessible. Consequently, schools have more flexibility with regard to programming and building modification than is generally thought.

Accessibility means that every room in every building must be accessible to every student. True/False

Equipment costs should include new equipment, regular maintenance and equipment _____ for the handicapped.

Answer: false; modifications.

4: State Funding Practices. The manner in which states allocate funds for handicapped students affects costs in a variety of ways. A variety of state-funding mechanisms exist throughout the United States; each state has its own unique system. While it is not possible in this booklet to cover each state's individual practice, they can be grouped into general categories. The discussion below suggests how these mechanisms affect alternative strategies and costs for educating handicapped students and will assist you in comparing strategies.

A. *Unit Financing.* States using this mechanism reimburse districts a fixed sum for each designated unit of classroom instruction, transportation, and administration. Some of the difficulties inherent in this approach are (1) states are motivated to increase class size in order to decrease costs; (2) small districts are unable to qualify for administrative and institutional support units; (3) start-up funds are missing, especially a problem for mainstreaming programs; (4) students are inappropriately placed in a lower per pupil cost program when units are allocated for differing class sizes on the basis of disability; and (5) all programs are reimbursed indentically regardless of cost and quality (Thomas, 1973).

B. *Weighted Formula.* Weighted formulas allocate a flat amount for regular per pupil expenditure plus an added amount (represented by a weight multiplied by the regular per pupil amount) which usually varies according to disability. One western state, for example, counts each exceptional child as three regular students (Thomas, 1973). One southern state, on the other hand, assigns weights by grade and by category of exceptionality (Bernstein, *et al.*, 1976).

When weights are computed using national figures, these costs are usually obscured. Some analysts have suggested that cost differential should be computed on the basis of state figures rather than national figures in order to provide a more accurate estimation of needs (Johns and Morphet, 1975).

There are other problems with weighted formulas. When state figures are used to compute weights, districts with higher costs may not receive adequate funding. Further, if the same weight is used for all categories of exceptionality, districts are not financially motivated to establish programs for children with disabilities requiring larger expenditures. Finally, employing a consistent weight assumes that all needs within a category of exceptionality are identical, an assumption which largely defeats the goal of individualized programming and of attention to unique learner needs regardless of exceptionality (Thomas, 1973). As Bezeau (1977) observed:

> Special education weighting factors have tended to solidify the previously existing inequality of opportunity rather than to compensate for it. (p. 511)

C. *Precentage Reimbursement.* Under this mechanism, schools are reimbursed a percentage of the full costs incurred in providing for handicapped students. In one central state, for example, the state pays 70% of the costs of educating handicapped students (Bernstein, *et al.*, 1976). Although this method averts some of the difficulties of the unit and weighted formulas, it may encourage schools to place students in the least expensive program alternative regardless of need in order to decrease the amount of total fiscal obligation at the school level (Bernstein, *et al.*, 1976).

D. *Reimbursement for Personnel.* States using this method provide funds to school districts to offset the costs of hiring special staff. In one central state, a particular amount is allocated per special education teacher, school psychologist, special education director, etc.

Under this method, mainstreaming programs may suffer financially if methods are not established to fund personnel who work with non-handicapped students as well. If such a mechanism is absent, schools are faced with an incentive for special class placement. This method may also encourage larger class sizes to reduce per pupil expenditures and may neglect the costs of supplies, equipment and transportation (Thomas, 1973).

E. *Straight-Sum Reimbursement.* A straight-sum reimbursement formula allocates to districts a set amount for each handicapped child. In one western state, for example, a set amount is provided for each Educable Mentally Retarded (EMR) student, and other amounts for emotionally, physically, multiply handicapped, Trainable Mentally Retarded (TMR) and homebound students (Bernstein, *et al.*, 1976).

Although a set number of students is not required for funding, labeling and fiscally advantageous placement may be encouraged instead of placement according to educational need (Thomas, 1973).

F. *Excess Cost.* This formula incorporates cost estimates of educating a handicapped student in a district and subtracts from this the cost of educating a regular student. All or part of the excess is then reimbursed by the state. Cost components may include administrative services, staff salaries, transportation, ancillary services, instructional materials, and in some instances, capital and construction costs.

In theory, excess-cost formulas encourage states to make the best instructional placement since financial barriers are, in many respects, removed. Problems arise when reimbursement occurs on the basis of a percentage of excess cost. In this instance, the same problems occur with excess-cost reimbursement as occur with other methods of financing (Thomas, 1973).

The greatest difficulty is in determining the components of excess cost. At present no precise technique exists to determine its make-up (Marinelli, 1975). Distinctions must be made between operating and start-up costs, particularly with respect to mainstreaming programs. Also, the method by which indirect costs are charged against special programs can have a significant bearing on the magnitude of excess costs and resulting cost indices (Marinelli, 1975).

Two new methods have been developed for determining excess costs. The step-by-step method computes excess cost by delivery systems within categories of exceptionality. Incidence rates, program alternatives and price levels are used in the computation (Taylor, 1973). An accounting-system model developed by Ernst and Ernst (1974) computes excess costs on the basis of planned versus actual use of resources and cost per 16 minutes of instruction. The model allows for scrutiny of deviations from planned use of resources taking into account student enrollment, resource-mix consumption and price changes. The accounting system model is a management control device rather than a method for estimating future costs. Further, accounting requirements are great and associated costs are high, leaving its utility as a costing device rather question. Both the step-by-step and the accounting system model use historical data which do not reflect current and future need (Marinelli, 1975).

Please indicate which type of formula matches the suggested definition.

a. Reimbursed a flat amount for regular per pupil expenditure plus added amount that varies by disability.

b. Cost estimates for serving a handicapped student less the cost of serving a non-handicapped student.

Answers:
Weighted formula reimbursement; excess costs reimbursement.

5: Federal Funding Practices. Over the past decade,the proportion of Federal aid to education has been steadily decreasing, reaching a peak in 1967 of 16% of total expenditures to about 7.8% in 1975-76 (Weintraub, Abeson, Ballard and LaVor, 1976; Goertz, Maskowitz and Sinkin, 1978). These figures are only averages, however. Some states receive more than 15% of their educational costs in Federal funds while other states receive less than 4% (Goertz, *et al.*, 1978). Although the proportion of Federal share has decreased, the total amount of Federal assistance has increased from about $760 million in 1961 to $4.2 billion in 1974 (Goertz *et al.*, 1978).

The pattern of Federal assistance to states for education has been of a categorical nature. Since 1972-73, however, the trend has shifted from categorical aid to Federal revenue sharing (Weintraub, *et al.*, 1976).

One educational "category" that has not received cutbacks has been education for the handicapped. The Federal share of educating handicapped students is currently about 12%, and under present law could be more if Congress chose to appropriate the funds.

Federal aid to states for educating handicapped students has been intended to serve as a catalyst for stimulating the development of programs and services for the handicapped. Unfortunately, the very nature of Federal funding practices and the lack of enforcement of Federal guidelines and policies have encouraged states to channel their efforts more toward the procuring of Federal funds than in judiciously and equitably implementing Federally supported programs.

The Vocational Education Amendments of 1968 intended that states devote some of the money appropriated under the act for vocational education for the handicapped. To do this, the act specified that 10% of the money allotted to each state be "set-aside" for this purpose. The intent of the legislation, in addition to providing a wider range of vocational training and the development of new vocational training programs for the handicapped, was that the 10% set-aside would inspire state matching. The Federal support was intended to serve as seed money for follow-through state effort. A follow-up survey of states conducted by the General Accounting Office found that the provisions of the act failed to create the intended incentive. Study findings suggest that:

- An overall average of 11% was spent for the handicapped.
- No state over a four-year period supported efforts for the disadvantaged and handicapped to the same extent as its overall Part B program.
- While the nationwide average ratio of state and local funding for all Part B programs in fiscal year 1973 was $5.93 to $1.00, the ratio for programs serving the handicapped was only $1.10 to $1.00.
- In fiscal year 1973, 19 states spent fewer state and local dollars for every Federal dollar for the handicapped than they had in fiscal year 1970.
- Some states, over a three-year period, spent no state or local funds for the handicapped while continuing to receive Federal assistance for such programs.
- In other states, state and local funding has been withdrawn as Federal funding has increased.

(Weintraub, *et. al.*, 1976, p. 185)

The majority of vocational offerings were found to be limited with handicapped students placed in segregated programs. Interestingly, it was found that handicapped enrollment declined in the period 1971-73 in spite of increased Federal expenditures (Olympus Research Corp., 1974).

The failure of the 1968 Vocational Education Amendments to create state incentives for providing vocational training for handicapped students resulted in requirements in the 1976 Education Amendments, P.L. 94-482, that include continuance of the 10% set-aside provision as a minimum amount of monies to be spent in programming for handicapped students—with the provision that states or local areas must match such funds on a dollar-for-dollar basis. Other provisions of the 1976 Amendments include opening the

regular vocational program to the maximum extent possible in order to reduce the number of handicapped students in segregated vocational classes; spending funds for handicapped students consistent with the state's plan submitted under the Education of All Handicapped Children Act, P.L. 94-142; using the 10% set-aside monies to address the added costs necessary to overcome the inability to succeed in regular vocational classrooms for individual handicapped students.

The Education of All Handicapped Children Act of 1975 (P.L. 94-142) provides funding through an essentially excess-cost allocation mechanism. The law defines excess cost as:

> Those costs which are in excess of the average annual per student expenditures in a local education agency during the preceding school year for an elementary or secondary school student, as may be appropriate, and which shall be computed after deducting a) amounts received under this part or under Title I or Title VII of the Elementary and Secondary Education Act of 1965, and b) any state or local funds expended for programs which would qualify for assistance under this part or under such titles (Part B, Sec. 611).

As an excess-cost mechanism, it is subject to all the advantages and disadvantages discussed earlier under excess-cost funding practices of the states.

The fiscal allotment to each state is made on the basis of the number of handicapped children being served in each respective state. There is the added specification, however, that the number in any state may not exceed 12% of the total number of children in the school-age population of the state. Presumably the purpose of such specifications is to discourage indiscriminate labeling by states for the purpose of procuring Federal funds. Experience may prove, however, that the numbers spelled out in the law are unnecessarily restrictive in some states.

SUMMARY OF COST CONSIDERATIONS

The costs of accessible education for handicapped students will vary substantially by type of strategy considered and by geopolitical factors affecting the educational unit. Since actual dollar estimates of certain strategies become quickly dated, it is more important to have an approach that you can use in the future to consider costs and to integrate those considerations into a model for comparing strategies.

An important element of a good costing mechanism is an accounting system consistent with cost-data requirements. Line-item budgeting, while acceptable in the past, is no longer adequate for current purposes. Administrators who abide by the USOE *Handbook II* (Revised) regulations generally have a useful and workable accounting system.

Although much of the foregoing discussion has centered around costs associated with handicapped students, a comprehensive approach to costing should be the goal. Rather than viewing costs associated with special students, vocational education and other educational programs as isolated pieces of information, it is more important to look at the mechanism for gathering the data and utilizing them as part of a total planning process. Buildings, equipment, transportation and programs will have to be flexible enough to serve multiple purposes. Education appears to be moving away from the use of labels for students, and consistent with the concept of equal educational opportunities, moving more toward viewing each child as unique and deserving of individualized

programming. It is recognized that *even students* falling into the "regular" category may, at some point, if only temporarily, require the services that have been traditionally reserved for "exceptional" students, such as resource room placement. Viewed in this way, accessibility costs can be spread across the student population rather than being assigned to a few students.

There is a need for incorporating qualitative variables in the process of cost analysis and resource allocation. As emphasized earlier, sophisticated costing studies that fail to acknowledge and accommodate political forces as well as other qualitative dimensions of the school environment often fail in their mission. As Fielden (1978) suggested:

> The audience for the analysis is a key factor since...different levels have different perceptions of cost, varying political control over cost categories and a greater or lesser interest in certain cost elements. All these points will be relevant to cost methodology. (p. 24)

The challenge is in incorporating these qualitative dimensions without information overload.

Decision Matrices

One technique useful for setting priorities and choosing between alternate strategies for removing barriers is Decision Matrices.

As a decision-making technique, it evolved from a branch of management science called decision theory. Turban and Meredith (1977) define decision theory as: ". . .a systematic quantitative and normative approach to the study of decision making. It seeks methods for selecting the best course of action from a set of possible alternatives." (p. 43) Although the determination of which is the "best" course of action is judgmental, the Decision Matrix allows the judgment to be quantified for ease in choosing among alternatives. It is a device for ordering and displaying small pieces of information in a form such that their consequences and implications of interaction can be evaluated. After using the procedure, you will have developed a list of criteria for evaluating strategies and will have evaluated various strategies on the basis of your selection criteria.

STRENGTHS AND LIMITATIONS OF DECISION MATRICES

Decision Matrices enable you as an administrator to quantify certain aspects of the decision-making process about strategy selection. Issues you must consider are organized and systematically presented. As a result, you will be able to order your thinking logically and to use the technique to select and justify your rationale and decisions about alternate strategies.

Use of the technique also creates an awareness of the complexity of a situation while at the same time offering a framework for managing the diverse elements of your choice. Since each strategy is broken down into component parts, the decision process often seems less overwhelming.

Finally, the Decision Matrix approach can be implemented with equal effectiveness by a group or by an individual. The richer variety of input provided by a group often increases the power of the technique as a procedure for selection among alternative strategies.

The major limitation of the technique is that the decision is only as good as the information upon which the decision was based. If users of the technique are not insightful in identifying the relevant dimensions of a problem, the technique will not be worthwhile.

Name three things the Decision Matrix approach permits the user to do with alternative strategies for removing barriers.

1. _____

2. _____

3. _____

Answer:
Quantify aspects of strategies; organize aspects of various solutions; select among solutions; justify solutions

_____

WHEN SHOULD DECISION MATRICES BE USED?

The Decision Matrix approach for strategy selection works best when the alternative strategies to be considered are small in number and the selection criteria are finite. Sometimes, you will have to think about a problem as having a finite set of *feasible* alternatives although the number of alternatives in theory will be much larger.

When groups, such as your Local Planning Committee or other decision-making bodies, implement the technique, some guidelines must be used. The group should be relatively small since large numbers of people make mathematical calculations time-consuming and cumbersome. The group also should be willing to have simple, mathematical procedures represent group thinking.

Generally, the technique is most appropriate for selecting among alternative strategies, for managing diverse inputs, for establishing resource allocation priorities, and for providing justification for decisions to those persons to whom administrators are accountable.

MATERIALS AND RESOURCES REQUIRED

If the procedure is used by an individual. resource expenditures are minimal. If the relevant dimensions of the strategies are conceptualized and though through before the use of the procedure, the process could require as little as one hour. If a group uses the technique, the process will consume about one day. No special fiscal resources are required for implementation except for the user's time.

For individual use, no more than paper and pencil are required. Although a calculator would be helpful, it is not essential. For group use, newsprint, easel and markers or a blackboard would be helpful in addition to paper and pencils for group members. Groups should also have use of a room where they can work undisturbed for a day or less.

HOW TO IMPLEMENT A DECISION MATRIX

You must first decide whether you or a group of two or more people will compare strategies using a Decision Matrix. Do not involve others in a group situation unless realistically you can allow everyone to have an equal voice in evaluating the alternatives and setting priorities. If you are the one who will ultimately make the decision, call on others in an advisory capacity as needed rather than assembling a group.

Activity 1: Define the Problem and State Objectives. Identify the specific objectives you hope to accomplish in using the technique. You may, for example, wish to select one of three possible alternative strategies for serving hearing-impaired students in a vocational program, all of which are feasible in your particular setting. You may have other objectives as well such as the involvement of key staff or other persons in the decision-making process.

Your goal should be to specify as clearly as possible what you wish to achieve so that you can evaluate your efforts at the conclusion of the implementation phase.

Activity 2: Review the Set of Strategies. The alternative strategies for barrier removal are the products of Step 3 of the Planning System. If you are the sole implementer of the Decision Matrix, you must review the entire list of strategies giving particular attention to those that were considered most important by the LPC. As you consider the list, omit those options that are not feasible; strive for a list of three to seven alternative strategies per objective. You can consider more than seven, but as the number increases, so does the complexity of comparing them. You must weigh the advantages of including extras against the time required to evaluate them. Closer scrutiny will often reveal strategies that you are skeptical about and would eventually omit anyway.

If a group will use the Decision Matrix, a group discussion can result in the working list of alternative strategies to consider in short order. If you anticipate problems, however (the members don't know each other or tend to be silent), you can use a modified group decision-making technique such as the Nominal Group Process to narrow the list of strategies. Detailed instructions for implementing the modified Nominal Group Technique are found in the Step 2 booklet of the Planning System, Establishing Priorities and Goals.

Activity 3: List Criteria. Once you have decided upon which strategies to compare, you must develop the list of criteria upon which you will judge the strategies under consideration. In the Guide to the Planning System were noted eight suggested criteria upon which to compare alternative strategies. You and your Local Planning Committee should select among these criteria and/or create your own criteria for comparisons. When a goup is working through this activity, you may have difficulty keeping the list of criteria small enough to be manageable. If this happens, combine several criteria under one heading or under one of the suggested criteria.

As you select and list criteria, your final list with the questions of each might look like the following:

CRITERIA

TECHNOLOGICAL VALIDITY

- How effective is the strategy in doing what it was designed to do?
- How effective is the strategy by the standards the school uses to evaluate it and similar proposals?
- How many, what proportion, etc., of the target group would be reached by the strategy?
- What is the probability that the target group would accept the strategy?

ADMINISTRATIVE FEASIBILITY

- How many major changes would be required to implement the strategy? (The more changes and the greater the change required, the *less* feasible.)
- What amount of start-up costs and resource build-up would be required? (The more start-up costs and resource build-up required, the *less* feasible.)
- How much coordination and consensus is required? (The more coordination and consensus required, the *less* feasible.)
- How much time is required to implement the strategy? (The more time required, the *less* feasible.)

COST

- How much money for items such as buildings, materials, supplies, equipment, personnel, renovation and transportation does the strategy require?

You may prefer to use an effectiveness-cost ratio rather than a single cost criterion. To do this, determine or estimate the effectiveness of each strategy (i.e., How well does each do what it was intended to do?) and rank strategies 3, 2, 1 for high, medium and low order effectiveness. Then evaluate each for cost using the same procedures of ranking 3, 2, 1 for high, medium and low costs. Your effectiveness measure will be the top figure of the ratio and the cost figure will be the bottom one.

Under each criterion, be sure to list the sub-items that you decided were components of each. These should be in plain view for the remainder of the implementation.

Activity 4: Determine the Relative Importance of the Criteria. Rank the criteria in terms of importance from most to least important. Usually no two criteria are given the same ranking. After you have ranked the criteria, assign each criterion a number which expresses its relative importance. You may take the number of criteria and use these sequentially as weights. For example, if there are four criteria, your rankings might range from 1 to 4 with the most important receiving a 4 and the least important a 1. If you wish to weigh some criteria heavier than others you may use a different numbering system. After ranking them, you may decide that criterion #1 is 4 times as important as criterion #2. In this case, your weightings would look something like this:

Criterion #	Weights
1	12
2	3
3	2
4	1

When a group is involved, each member assigns a rank privately and all weights or ranks for each criterion are averaged to arrive at a single weight for each criterion. Notice below that the weightings for each criterion have been averaged to arrive at a single weight for each criterion.

Criterion	Smith	Jones	Hughes	Average Weight
1	6	4	2	4.0
2	4	3	1	2.7
3	2	2	3	2.3
4	4	6	5	5.0

Why are the criteria ranked from most important to least important?

Answer:
In order to assign relative weights to the items.

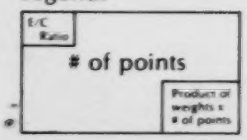
Activity 5. Rate the Strategies According to Criteria. Examine each strategy on the basis of how well it meets each of the criteria. This procedure is similar to the procedure you used in Activity 4 to assign weights. Use the Decision Matrix provided on the following page as an example in displaying your calculations.

One of several rating systems would be appropriate here. One system that has been used successfully is to judge the merit of each alternative on a scale from -10 to +10 with -10 being the worst possible score and +10 the best. The use of such a wide range of rates provides more variance among alternative strategies than does, for example, a 1 to 3 scale.

SAMPLE DECISION MATRIX

STRATEGY	CRITERIA: ③ Technological Validity	CRITERIA: ① Administrative Feasibility	CRITERIA: ② Effectiveness/ Cost Ratio	TOTAL SCORE
#1	3 / 9	8 / 8	1/1 / 1 / 2	19
#2	6 / 18	4 / 4	3/1.5 / 2 / 4	26
#3	-3 / -9	-2 / -2	2/.75 / 2.7 / 5.6	-5.4

Legend:



◯ = Weight of criterion

When a group is involved in using the Decision Matrix Technique, develop an average rating on each criterion for each strategy. The procedure is the same as that for calculating average weights.

Activity 6: Calculate Point Values. For each criterion and each alternative strategy, multiply the rating by the weight for the criterion. In the sample Decision Matrix, the point value is displayed in the block in the lower right corner of each cell. For example, the number of points for alternative #3 on the criterion technological validity is determined by multiplying the rating on that criterion (-3) by the weight of the criterion (3) yielding a product of -9; note that the point value is displayed in the lower right corner of the cell.

Briefly describe how to calculate point values for each alternative strategy.

Answer:
Multiply the rating of the alternative strategy on the criterion times the weighted value of the criterion.

Activity 7: Calculate Total Points for Each Alternative. Add points contained in the lower right-hand corner of each cell for each alternative strategy; display totals at the end of each row. Notice that in the sample Decision Matrix, strategy #3 has a total of -5.4 indicating its inferior status relative to the other two alternatives.

Activity 8: Compare Alternatives and Set Priorities. Compare the point totals of the alternative strategies and assign priorities or ranks to the strategies on the basis of the totals. Notice in the sample Decision Matrix that strategy #2 has the highest point value with 26 points, thus giving it first place priority. Strategy #1 has the next highest point value with 19 points, giving it second place priority. Strategy #3 is last priority with a point value of -5.4.

Strategy	Rank	Point Value
1	2	19
2	1	26
3	3	-5.4

The problem of selecting among alternative strategies may not be resolved completely by this process. The final decision will depend not only on your comparison of strategies according to the criteria but as well on the feasibility of allocating resources proportionately among two or more alternatives. You may, for example, decide to allocate 75% of available resources to strategy #1 and the remaining 25% to strategy #2. Combinations of more than one strategy are encouraged.

Where a group is involved in assigning point values, the total should be divided by the number of individuals in the group, thereby arriving at an average total point value for each alternative strategy. The rationale for the use of the technique with groups is that group members will more readily arrive at a decision on a complex issue if there is an analytical tool available to direct their efforts. Through such a process that forces consensus, the final decision should be more acceptable to all concerned.

ADDITIONAL RESOURCES

There are several good resources of additional information about Decision Matrices, each of which offers a slightly different variation of the technique. Three such sources, together with brief annotations, are noted below.

Jantsch, E. *Technological Forecasting in Perspective.* Paris: Organization for Economic Cooperation and Development, Publication Center, 1969.

This volume contains an example of the Decision Matrix Technique applied to an educational problem.

Turban, Efraim, and J. R. Meredith. *Fundamentals of Management Science.* Dallas: Business Publications, Inc., 1977.

This discussion explains the theoretical underpinnings of Decision Matrices as they evolved from decision theory. All examples are from business and industry.

Spiegel, A.D., and H. H. Hyman. *Basic Health Planning Methods.* Germantown, Md.: Aspen Systems Corporation, 1978.

This is an excellent step-by-step description of how to implement the basic Decision Matrix technique and several of its variations. Examples are provided for illustration and, although they deal with health issues, the procedures are readily generalizable to educational situations.

Cost Benefit-Cost Effective Analyses

Cost-Benefit (C-B) Analysis and its derivative, Cost-Effectiveness (C-E) Analysis, are techniques for determining optimum allocation of resources in comparing alternative strategies for barrier removal.

C-B and C-E Analysis both enable the user to compare costs with outcomes as a means of choosing the alternative strategy with either the maximum benefit to the target group as in the case of cost-benefit analysis or maximum attainment of objectives as in the case of cost-effective analysis. The major difference in the two techniques is that outcomes in C-B Analysis are expressed in monetary terms whereas outcomes in C-E Analysis normally are not. Further, C-B Analysis has a more long-term focus than C-E Analysis. C-B Analysis typically has been applied to broad areas of policy formation or gross resource allocation decisions. C-E Analysis is more useful on a smaller scale in choosing among alternative strategies and is more flexible. Together, these two techniques offer a useful approach for comparing strategies, allocating resources, planning and/or evaluation.

The approach described in this section is a hybrid of cost-benefit, effectiveness and efficiency measures. Efficiency, expressed as cost per unit of output, is generally inappropriate by itself as an evaluation/planning/decision-making device, yet when used in combination with other outcome measures such as C-B and C-E Analyses, it can enrich a study and contribute significant input to cost-containment efforts. The goal in this section is to offer this three-faceted approach to the evaluation of alternative strategies based on the assumptions that a combined approach saves time and offers a more realistic view of educational issues and possible alternatives.

Can you recall the difference between cost-benefit and cost-effectiveness? Place a "B" beside those items that describe Cost-Benefit Analysis, an "E" beside those items that describe Cost-Effectiveness and "B-E" beside those items that describe both.

___ A technique for resource allocation, planning and evaluation
___ More useful for broad policy-level decision-making
___ Outcomes are usually not expressed in monetary terms
___ The more flexible of the two

Answers:
B-E, B, E, E

If you choose to use all the measures detailed in this section of the manual, you will, at the conclusion of your comparison process, have developed measures of cost-effectiveness, cost-benefit, cost-efficiency and performance. Their use and interpretation depend heavily on the goal of your program development effort as well as the objectives of the alternative strategies under consideration.

Although discussed as though they are separate techniques with separate meanings and interpretations, C-B and C-E are not separate for the purposes of this manual. Their separate inputs are available for a multi-faceted view of alternative strategies. Each measure may be used or interpreted independently but the task of a combined interpretation of results is much more difficult. For this reason, the measures are integrated as a single approach with the option remaining of omitting those that are inappropriate for the strategies under consideration.

TYPES OF COST-BENEFIT COST-EFFECTIVENESS MEASURES

Cost-Effectiveness Measures. Once costs and effectiveness measures of the alternative strategies/courses of action have been determined and specified, you must develop an effectiveness/cost (E-C) ratio. The larger the ratio, the more desirable the alternative. The ratio should exceed 1 if the effectiveness exceeds cost. A ratio of 1 is interpreted to mean that cost and effectiveness measures are almost equal. Where ratios are very similar, the user will need to bring to bear other qualitative information in order to determine the optimum course of action. Some of those qualitative considerations will be detailed in the implementation procedures.

Cost-Benefit Measures. Three other products also are possible with this analysis, depending on your needs as the user. These are measures of cost-benefit, cost-efficiency and performance. Cost-benefit, as used in this manual, is a measure of the relationship between strategy costs and strategy benefits, expressed as program completers' future income increases that occur as a result of training. It is possible to omit this section of the analysis, especially at the secondary school level, if time and resources are a constraint or if this kind of information is not one of the objectives of your program or barrier removal process. At the post-secondary level, the measure has more relevance than at the secondary level. At the post-secondary level, students sometimes are sacrificing one or more years of income from working in order to receive training. It may be important to determine whether the benefits of this sacrifice outweigh the costs. This kind of information can be used as justification for a particular strategy. It also can be used to compare the value of vocation education versus on-the-job training or other such options. There are varieties of benefits other than increased income that result from training. There is the psychic benefit of increased self-esteem that results from increased competence, the benefits to society of increases in tax contributions, the higher the probability of remaining self-sufficient and avoiding contact with the welfare, court and judicial systems. In order to be incorporated into the analysis, benefits must be expressed in monetary terms but the technology for doing so is presently rudimentary. For the purposes of the example outlined in this manual, benefits will be expressed in terms of income increases.

If you decide to include cost-benefit measures in your study, there are three component measures that can be computed. The benefit-cost (B-C) ratio is the most commonly known measure of cost-benefit. When the ratio exceeds 1, benefits theoretically outweigh costs. The net present value (NPV) expresses the differences between the present value of costs and the present value of increased incomes. NPV is considered by many to be the superior measure of C-B. The internal rate of return (IRR) is the interest ratio which makes the present value of increased income equal to the present value of costs. It is, by itself, used as an investment criterion measure and has value in the area of policy development.

Cost-Efficiency Measures. Cost-efficiency expresses the relationship between strategy costs and units of output. In a comparison analysis, the most efficient strategy is the one providing the most output for the least cost per unit. You must remember, however, that the most efficient alternative strategy may not necessarily be the most effective or beneficial strategy in the long run.

Performance Ratio. The performance ratio is calculated by dividing the strategy effectiveness measure by the cost-efficiency measure. This measure can be thought of as a summary device which combines effectiveness and efficiency measures. It is not a substitute for either efficiency or effectiveness measures but rather a companion to them.

Cost-effectiveness is expressed as:

a. a ratio of benefits to effectiveness
b. an efficiency index
c. a ratio of effectiveness to costs
d. a ratio of costs to effectiveness

Which of the following measures is optional for the purposes of this manual?

a. cost-benefit
b. cost-efficiency
c. cost-effectiveness
d. performance

Which of the following represent(s) measure(s) of cost-benefit?

a. net present values
b. internal rate of return
c. E/C ratio
d. a. and b.
e. all of the above

Which of the following is probably least useful when taken alone?

a. cost-benefit
b. cost-effectiveness
c. cost-efficiency
d. performance

Which of the following is a ratio of cost-effectiveness to cost-efficiency?

a. performance ratio
b. B/C ratio
c. net present value
d. internal rate of return

Answers:
c, a, d, c, a.

STRENGTHS AND LIMITATIONS OF COST-BENEFIT-EFFECTIVENESS

There are a number of strengths and limitations of C-B-E as a strategy comparison device. Among the strengths, C-B-E permits comparison of several strategies or sets of strategies with different objectives; expresses abstract concepts in monetary terms which are easy to communicate to lay people; permits the comparison of several strategies at once; may serve the joint purpose of program evaluation and planning; generates data that can serve multiple purposes; and can be fed directly into certain phases of programming, planning and budgeting in educational units where program budgeting is employed.

The limitations of C-B-E are relatively few, but must be considered carefully. Specifically, C-B-E is costly, time-consuming, and often requires several people to conduct the analysis.

WHEN SHOULD COST-BENEFIT-EFFECTIVENESS BE USED?

C-B-E should be used when a variety of strategies with different objectives must be compared. It also is useful when the planning for accessibility will be coordinated with the overall educational planning efforts of the educational unit or when the technique is typically used for planning purposes by the educational unit.

RESOURCES AND MATERIALS REQUIRED

Required resources and materials include personnel, calculators, paper and pencils, and frequently computer time. By far, the greatest expenditure is personnel time since usually more than one person will be involved in using the technique.

HOW TO IMPLEMENT COST-BENEFIT-EFFECTIVENESS ANALYSIS

There are two major phases of activity involved with conducting C-B-E: planning and implementing. For purposes of clarity, the following discussion is divided into two sections, one for each phase.

PLANNING

Activity 1: State the Purposes of the Formal Strategy Comparison Process. This statement will help focus thinking. This will be a general statement of the reason that the comparison is being conducted. A statement of purpose may appear like this:

> A C-B-E study will be conducted to supply information for budget planning and program development.

Despite a desire to identify and select the "best" alternative strategies available, it is more important to set reasonable goals and objectives, keeping in mind the financial, political, administrative and social constraints within which the school operates. A particular program or instructional strategy may have a high B/C or E/C ratio but without institutional support, acceptance and necessary technical capabilities, there is no hope of implementation. Remember that C-B-E does not deal explicitly with some of the suggested criteria for strategy selection discussed in the *Guide*.

Activity 2: Define the Scope of the Study. To the degree possible, try to be specific in answering questions such as:

- What is the breadth of the analysis? Will this be a comparison of all suggested strategies or will the scope be narrowed to specific strategies?
- What will be the time frame of the comparison? How long will it last? When will it begin? When will it end? What time periods will be included in the comparison process?

Most C-B studies look at historical cost data extending several years back and look at far-reaching costs and benefits sometimes projecting to future generations of people. C-E studies are tied to the current situation, generally encompassing no more than one- or two-year periods. Limitations of time and resources often prohibit an extensive analysis in most educational units. It is crucial at this point for you to define the time frame of your study in order to reasonably estimate resource requirements.

Activity 3: List the Objective(s) of the Study. Be specific here. Objectives should answer the questions who, where, when and what. See if you can supply the answers to these questions in the space provided below for performing the C-B-E in your educational unit.

- Who is to be conducting the comparison and coordinating the activity?
- Where is the comparison to take place?
- When is the comparison to be conducted? Over what span of time? When will it start? Approximately when will it be completed? Note: Some C-B-E studies can require up to one school year for completion.

- What specific activities will be conducted?

- What information is to be collected?

Activity 4: Specify Data. The kinds of data to be collected and analyzed must be noted. Although there may and probably will be modifications as the comparison progresses, try to identify, as thoroughly as possible, the kinds of data that are available and can be included in the study. The figure below suggests examples of the types of data you must consider.

COSTS OF VOCATIONAL EDUCATION STRATEGIES FOR HANDICAPPED STUDENTS

Direct Costs
- Staff salaries
- Fringe benefits
- Purchased services
- Supplies/materials
- Equipment
- Space/building

Indirect Costs
- Administrative and support services

Opportunity Costs
- Student's foregone income while enrolled in school

Miscellaneous Costs
- Cost of accessibility modifications

Excess Cost
- The "added" cost (over that of educating a regular student) of vocational education for handicapped students

EFFECTIVENESS OF VOCATIONAL EDUCATION PROGRAMS FOR HANDICAPPED STUDENTS
- Standardized test scores
- Grades
- Rating scale results
- Attitude survey results
- Job placement figures

BENEFITS OF STRATEGY IMPLEMENTATION FOR HANDICAPPED STUDENTS

Average annual income for program completers vs non-completers/non-participants

Average annual income growth rate for program completers vs. completers/non-participants

Spillover effects/benefits to third parties

Psychic benefits of program completers vs non-completers/non-participants

Benefits to society in terms of reduced burden on welfare and court systems of completers vs non-completers/non-participants

Benefits to school system and vocational program

EFFICIENCY OF VOCATIONAL EDUCATION PROGRAMS FOR HANDICAPPED STUDENTS.

Total strategy costs divided by:
- Total number of students
- Credit hours
- Number of program completers
- Total budgeted program costs

As you examine the example in the figure, you should think about the following strategies generated in your educational unit in light of the following questions.

- Which of these data are readily available to you?
- Which kinds of information are not presently available or not usable in their present form?
- What data do you need that you do not currently have?
- What steps can you take to get the kinds of data that you need to conduct your study?
- Do you now have or can you get the kinds of data you will need in order to carry out your study?

Activity 5: Specify Personnel. Consider and list the persons you will need to involve in conducting this comparison. After listing the individuals, you should contact each person to secure their involvement and to set a time and place for an initial meeting. The people to be involved in conducting the comparison should be involved in both planning and implementing the study. At your initial meeting, the following business should be conducted:

- Appoint a team leader if this person is not to be yourself.
- As a group, nominate an advisory committee composed of people sensitive to cost factors and the political climate within the school and the community.
- Assign specific responsibilities to each member of the team. For example, the team leader should schedule meetings and contact each member as to their time, place and purpose; coordinate activities of all members; set deadlines; make periodic written reports to superiors; and insure timely completion of all members' tasks.

Responsibilities should be delegated across team members. Examples of such assignments might include: team member #1, collect all specific cost information; team member #2, perform all computer analyses; team member #3, conduct cost analyses, make cost and benefit estimates, and report information to team member #1; team member #4, report periodically to faculty as to progress and collect outcome/ effectiveness measures.

Activity 6: Identify Other Resources. The other required resources might be identified during the planning phase of C-B-E. These will vary depending on the amount of necessary data available in usable form, the scope of the study, and so forth. Try to be as accurate as possible using the following categories of resource requirements as a guide.

Personnel
- 6-member study team
- 3-member advisory panel
- 2 clerical staff
- 1 consultant

Equipment
- Computer time
- Travel

Supplies
- Typing paper
- Xerox paper
- Report binders

If, at this point, financial resources appear to be a serious constraint, consider alternative sources of funds such as the school's research and development funds, the state's research and development funds, funds from the county commissioners, and donations from private groups and foundations.

Activity 7: Prepare a Budget. A fairly detailed budget should be prepared to insure that the comparison can be carried through to completion without undue financial constraint. The following format can be used as a guide and contains a sample budget with estimated cost data.

SAMPLE C-B-E BUDGET

Personnel	Time (total hr. involvement for study team)		Cost
6-Member Study Team	120	Team Leader (120 hrs @ $8/hr)	$ 960
	40	Team member #1 (40 hrs @ $7/hr)	280
	20	Team member #2 (20 hrs @ $7/hr)	140
	15	Team member #3 (15 hrs @ $8/hr)	120
	15	Team member #4 (15 hrs @ $7/hr)	105
	15	Team member #6 (15 hrs @ $6/hr)	90
Consultant	2 days	$150/day	300
		Subtotal	$1995
Travel	**Miles**		
	---		---
Equipment			
Calculator			No Cost
Computer time	½-day use		$50
Supplies	**Quantity**		
Xerox paper	1 box		$ 26
Typing paper	2 reams		24
Report binders & Rings	50		25
	50		10
		Subtotal	$ 135
		Grand Total	$2130

It is assumed that the study team will be composed of staff members already working in the school system. The costs budgeted for these people therefore represent a dollar estimate of the time they will devote to the study based on their hourly salary. A more realistic figure of the cost of a C-B-E study in terms of money paid out is excess cost. Including the consultant, the amount of money that would actually have to be paid out over and above those monies already designated for staff salaries is $435.00. Four hundred thirty-five dollars sounds much more manageable than $2130. In terms of time and effort expended, however, the total cost is still $2130.

Activity 8: Design the Comparison Study. The design should list the specific activities, subtasks of each activity, data needs, time and resource requirements and individuals responsible for completion. The figure below is a chart which you may use as a guide. For this phase, the assumption is made that preliminary planning is complete—that is, the study team and advisory committee have been formed and the purpose(s)/objective(s) of the comparison have been discussed, agreed upon and finalized.

DESIGN CHART FOR C-B-E STUDY

Activities	Sub-Tasks	Data Needs	Resource Requirements	Time Requirements			Individuals Responsible
				Begin	End	Total Time	
1. Indentify strategies to be included in the analysis							
2. Specify objectives of strategy							
3. Identify outcomes of strategy							
4. Determine costs of strategies							
5. Specify benefit effectiveness and efficiency measures							
6. Complete analyses • cost-benefit/effectiveness/ efficiency ratios • net present value • internal rate of return • performance ratio							
7. Interpret data							
8. Devise plan for data utilization							
9. Prepare report							

Activity 9: Hold Orientation/ Training Session. Assemble study team and advisory committee members and familiarize them with C-B-E concepts and methods. This can last up to a day depending on the learning needs of your study team members. Do a survey beforehand to identify the kinds of information needed by the group. Your sequence of activities for designing the workshop may appear something like this:

- Look at the task assignments identified in Activity 5; make a list of the skills necessary in order to perform those tasks listed.
- Survey your team to discover the degree to which members possess these skills; your product should be a list of learning needs.
- Design strategies for the workshop to meet these learning needs: use resource people, audiovisual aids, case studies and self-instructional packages as necessary.
- Make a list of and assemble resources necessary to implement the strategies.

Place these Planning Activities in their appropriate order by numbering them in the spaces to the left of the term.

a. ____ identify other resources
b. ____ design the comparison study
c. ____ define scope of comparison
d. ____ define objectives for comparison
e. ____ specify data for comparison
f. ____ state purpose of comparison
g. ____ specify personnel
h. ____ prepare a budget
i. ____ hold orientation study

Answers: f, c, d, e, g, a, h, b, i is the correct order.

IMPLEMENTATION

Once planning is complete, you are ready to implement your C-B-E study. If the planning has been thorough, implementation should proceed relatively smoothly. Be aware, however, that even the most carefully planned studies have to be revised occasionally. Try to anticipate problems and have several alternatives ready to cope with them.

A sequence of implementation activities follows this introduction. Although several of the activities may be completed simultaneously, it is important that frequent team meetings occur in order to share information, coordinate activities and cope with problems as they arise.

Activity 1: Specify Objectives for Each Strategy. Although simple in concept, this is often an activity that is slighted or given cursory treatment in a C-B-E analysis. It is essential to explore this activity with those concerned at all levels of programming. If this is not done, it is likely that a great deal of time and effort will have been expended on a product that will never be used.

Each potential strategy will have been designed for a specific objective and an overall goal. Review the original barriers, the goals established for the most critical barriers and the objectives suggested for the goal. Next review the suggested alternative strategies for achieving the goal and consider the fit between goal, objective and strategy. Lastly, specify in specific terms the objectives of each strategy in light of your review of how the strategy was developed. You may find that some suggested strategies are inappropriate or incongruous for the suggested goals and objectives; these strategies should be eliminated. Remember that objectives should specify who, what and when.

Activity 2: Identify Outcomes Outcomes are measures that reflect the degree to which strategy objectives have been attained. Depending, of course, on the content of the objectives, outcome measures can be expressed in terms of immediate effects such as student test scores and number of enrollees and completers, or in more long-term effects such as employment of graduates, earnings of graduates, job adjustment and job satisfaction.

To perform this activity, first examine the objectives listed in Activity 1 and list appropriate outcome measures. Next, establish a baseline from which to measure change. If the objectives of a set of instructional intervention strategies are, in aggregate, to increase handicapped students' math scores, then one would need some quantitative indication of the students' present math performance. Sometimes a baseline is not possible. In such cases, it is often helpful to look for sources in other schools, in students' backgrounds, or their performance in a baseline measurement period. For example, if an administrator is interested in conducting a C-B-E analysis of three alternative strategies for teaching vocational horticulture to make the program more accessible, it may be useful to either set up a tentative criterion of performance, applicable for a short period of time, using the students' performance during that period of time as a baseline from which to measure future performance.

Baseline data are important also in order to be able to compute as an outcome what would happen if nothing was done. For example, if students score high on a program pretest, that would be useful information to have in estimating future performance, should nothing different happen in the way of intervention. It may also show that the costs of particular intervention strategies outweigh their benefits compared to the status quo, as predicted by the pretest performance.

Activity 3: Compute Expected Effectiveness Scores For purposes of this manual, expected strategy effectiveness is expressed as a ratio of anticipated strategy outputs to anticipated strategy goals/objectives. The formula is:

$$PE = \frac{PO}{PG}$$

where: PE = program effectiveness
PO = program output
PG = program goals

The computation of an effectiveness score from initial objective formulation to PE computation may look something like this example:

Objective:

By the end of school year 80-81, the enrollment of handicapped students in the vocational program of Euphrates Community College will have increased by 25%.

Outcome:

Enrollment of handicapped students in vocational programs:

school year 1980-81 -		
beginning	end	(expected based
10	15	on registration)

Percent increase:

50%

Formula:

$$PE = \frac{PO}{PG} \; X\ 100^{*} = \frac{50}{25} = 2 \times 100 = 200$$

* Ratio is multiplied by 100 in order to make figures large enough to work with comfortably.

Where several objectives comprise a set of measures for a particular program, an average program effectiveness (APE) score can be calculated by adding all program output (PO) measures and dividing these by the sum of all program goals (PG) scores for the objectives involved. This number is then divided by the total number of PE scores. The formula is expressed as:

$$APE = \frac{\sum_{i=1}^{n} \frac{PO_i}{PG_i}}{N}$$

where:

- APE = average program effectiveness
- PO_i = all program output measures
- PG_i = all program goal scores
- N = total number of PE scores
- Σ = Sum of

If the objectives of a particular program have been weighted as to their relative importance, it is possible during the computation of PE measures to take the weights into account by assigning a numerical value to the weight and multiplying this by the numerator and denominator of the APE formula. The formula for the procedures (called weighted average program effectiveness) is expressed as:

$$WAPE = \frac{\sum_{i=1}^{n} \frac{PO_i}{PG_i} W_i}{\sum_{i=1}^{n} W_i}$$

where W_i = weight

Activity 4: Calculate expected benefit weight. As you remember, one of the basic differences between C-B and C-E Analysis as separate techniques is the long-term focus of C-B analysis and the relative short-term focus of C-E Analysis. Long-term benefits can be incorporated into the analysis at this point if such measures are congruent with the objectives of your strategies. This is a step that may be omitted if it does not suit your purposes or if time and other resources are scarce.

Benefits, in this study, can be expressed as the future earnings of program completers compared to non-completers. Taken further, benefits also can be expressed as growth rate of earnings of program completers over a period of years compared to non-completers.

In order to use future earnings as a figure that makes sense in today's world, you must take into account that a dollar earned several years from now would, theoretically, be worthless today. In other words, future earnings must be discounted to make them equivalent to today's dollars. The discount rate typically used is the current interest rate. Once future earnings are discounted by the discount or interest rate, the result is called the present value of a future sum. The formula for present value is as follows:

$$PV = \sum_{i=1}^{n} \frac{I'}{(1+4)^{t}}$$

where:

- PV = present value
- E = sum of
- I = future earnings/income
- t = time (in years)
- r = interest (discount) rate
- n = number of years

Before computing present value, it is necessary to calculate the increased income (II) earned by program completers compared to non-completers. This is calculated by subtracting the average annual income of non-completers (I') from the average annual income of

program completers (I). The total increased income (TII) is expressed as the sum of increased incomes multiplied by a function of the given annual growth rate. The formula appears as:

$$TII = \sum_{t=1}^{n} (I-I')(1+K)^{t-1} \text{ or, } \sum_{t=1}^{n} II(1+K)^{t-1}$$

The present value of these increased earnings can be computed by:

$$PVII = \sum_{t=1}^{n} \frac{II(1+K)^{t-1}}{(1+r)^{t}}$$

Activity 5: Indentify Program Costs. There are several ways of developing program costs depending on the strategy goals and objectives you identified during the planning phase. The suggested format has proven to be minimally confusing while at the same time encompassing relevant pieces of information. First, consider direct costs. These are costs related to direct program operation and include, for example, salaries and fringe benefits of teaching staff involved with strategy implementation. Salaries can be computed by the following formula:

$$S = \sum_{i=1}^{n} F \bullet T(\%)$$

where:

- S = annual salaries
- F = annual salary of individual faculty/ staff person
- T(%) = percent of time allotted to the program under comparison.

Fringe benefits can be calculated using the following expression:

$$FB = \sum_{i=1}^{n} (R+S+M+L+O) \bullet T(\%)$$

where:

- FB = fringe benefits associated with the program under study
- R = retirement contributions
- S = social security contributions
- M = medical insurance contributions
- L = life insurance contributions
- O = other benefits
- T = percent of annual teaching time alloted to the program under study

Other types of direct cost include items such as services purchased from individuals who are not on the regular payroll and for travel for instructional purposes, and the instructional supplies and materials bought for and consumed within the strategies under study. These costs should be prorated on the basis of the actual quantity consumed by the strategy under study using the following formula:

$$ISM = \frac{sch}{SCH} \bullet (C)$$

where:

- ISM = instructional supplies and materials
- sch = student contract hours for the program under study
- SCH = total student contact hours for all occupational programs
- C = total supplies and materials cost for all occupational programs

Another direct cost is equipment used wholly or in part in implementing the strategy under study. Equipment value (costs) are, for the purposes of this booklet, historical costs depreciated from the time of purchase. This value can be determined by dividing the purchase price (PP) by the life expectancy (LE), multiplying this by the age of the equipment in years (A) and subtracting this from the purchase price (PP). The following formula expresses this relationship:

$$\text{Equipment value} = PP - \frac{PP}{LE} \bullet A$$

If the equipment is shared by other programs outside of the strategy comparison, the equipment value should be prorated by multiplying the above formula by the percent of the time the equipment is used by the program:

$$\text{Equipment value} = PP - \frac{PP}{LE} \bullet A \bullet X(\%)$$

where:

- X(%) = % of time devoted to use in the program included in the Study

A last example of direct costs is the cost of instructional space used wholly or in part by the strategies being compared. Like equipment, the

building or space used must be depreciated in order to arrive at a true value. This can be arrived at by dividing the historical cost (purchase price) by the life expectancy, multiplying this by the age of the structure and subtracting this from the purchase price:

$$\text{Program building cost: } PP - \frac{PP}{LE} \bullet A$$

As with equipment costs, if the structure is shared by other programs, the actual structure value should be prorated by multiplying the above formula by the percent of time the structure is used by the program. This is calculated by:

$$PP - \frac{PP}{LE} \bullet A \bullet X(\%)$$

where:

X(%) =% of time building is used for instructional time for the program.

A second major category of costs is indirect costs or those costs that cannot be directly tied to a strategy or activity but provide support for a number of strategies and activities within the school. Examples include administrative services, student counseling, physical plant maintenance and operation, and general support costs from other departments. The outline which follows can serve as a general guide for figuring indirect costs by category.

Departmental, administrative and support services include the prorated salaries of the department chairperson and support staff, and the costs of departmental supplies and expenses. These costs can be prorated on the basis of student credit hours using the following formula:

$$PASC_d = \frac{sch}{SCHd} \bullet ASC_d$$

where:

$PADC_d$ = prorated administrative and support services costs of the program under study

sch = student credit hours within the program under study

SCH_d = total student credit hours within the department

ASC_d = departmental administrative and support services

A second type of indirect cost is *school administrative and support* services. These costs include the prorated salaries of deans and support staff and cost of supplies and other expenses. The variable used for prorating can be FTE (full-time equivalent) as in the following formula:

$$PASC_s = \frac{fte}{FTE} \bullet ACS_s$$

where:

$PASC_s$ = prorated school administrative and support services

fte = full-time equivalent teaching staff within the program

FTE = full-time equivalent teaching staff within the school

ACS_s = total school adminstrative and support services

A third example of indirect costs are the costs of other school-level administrative and support services. These costs include expenditures for libraries, student services, physical plant operation and maintenance, and auxiliary services for faculty and students. Library and student services costs can be prorated proportionately, for example, by dividing the number of students enrolled in the program under study by the total number of students in the school.

Physical plant operation and maintenance can be prorated for the program under study by dividing the proportion of instructional space used in implementing the strategy under study by the total building space and multiplying this by the total expenditures for plant operation and maintenance expressed as:

$$PPOMC_p = \frac{is_p}{TBS} \bullet X(\%) \bullet POMC$$

where:

$PPOMC_p$ = prorated physical plant operation and maintenance costs to the program under study

is_p = instructional space used by the program under study

TBS = total building space (including non-instructional space)

X(%) = percent of time used for instruction by the program under study

POMC = total costs for plant operation and maintenance

After you have computed all these indirect costs they should be totalled and the sum of the direct and indirect costs for the program under study must be derived. This figure represents the total cost of the program. For postsecondary schools, it may be useful to figure opportunity costs in addition to direct and indirect costs. Opportunity costs are represented by the foregone income of students enrolled in the program under study. You arrive at this figure by first taking an average of the income of high school graduates similar in age to those enrolled in the program under study who are not enrolled in postsecondary programs. You next multiply this by the number of years the program requires for completion. For example, if the program under study is a two-year program, you would multiply the average annual income of high school graduates not enrolled in a post-secondary program by 2. Once you have computed this figure, add it to the direct and indirect costs in order to obtain total program costs.

Stop here and check your understanding of the first five activities involved in C-B-E Analysis implementation. On the left side are listed the first five steps; on the right are terms associated with the steps. See if you can match them correctly.

1. Specify objectives
2. Identify outcomes
3. Compute effectiveness scores
4. Calculate expected benefit measures
5. Identify program costs

___ a. present value
___ b. direct costs
___ c. baseline measurement
___ d. plant operation and maintenance costs
___ e. program effectiveness
___ f. program output/goals
___ g. future earnings/income
___ h. instructional supplies and materials

Answer: a. 4; b. 5; c. 2; d. 5; e. 3; f. 3; g. 4; h. 5.

Activity 6: Compute Cost-Efficiency Measures. Cost-efficiency expresses the relationship between cost and units of output. It is an evaluation of the adequacy of program management. The procedures for calculating cost-efficiency are as follows:

Compute unit costs:

Divide the total program costs by the number of students to be enrolled in or served by the program.

Compute the cost-efficiency index for the program:

Divide actual unit cost by the budgeted unit cost. (This is for post-implementation evaluation only).

Activity 7: Compute Cost-Effectiveness Measures. The measure will be expressed as an E-C (effectiveness-cost) ratio. You must compute it by dividing the average program effectiveness index, the product of Activity 3, by the actual unit cost per student, the product of Activty 6.

Activity 8: Compute the Performance Ratio. Find the performance ratio by dividing the average program effectiveness index, the product of Activity 3, by the cost-efficiency index, the product of Activity 6. In pre-implementation considerations, this will be the quotient of the average program effectiveness index divided by the unit cost.

Activity 9:Compute Cost-Benefit Measures. Cost-benefit expresses the relationship between total program costs and program completers' future income increases as a result of program training. It includes net present value of future incomes, B-C or benefit cost ratio, and the internal rate of return. Steps in computing these are as follows:

First calculate the net present value or the difference between the present value of costs (C) which are program costs plus student opportunity costs in the first year of the program and the present value (PV) of increased incomes at a given discount rate (r). The formula for its computation is as follows:

NPV = PVII - C

where:

NPV = net present value

PVII = present value of increased incomes (see Activity 4, page 37 for PVII formula)

C = program costs + student opportunity costs in the first year of the program and the present value of increased incomes (PVII)

Second, calculate the benefit-cost ratio. This is derived by dividing the present value of increased incomes (PVII) by the present value of total costs (C). The formula for its computation is:

$\frac{PVII}{C}$ (see page 37 for references)

Third, compute the internal rate of return, the interest rate (r) which makes the present value of increased incomes equal to the present value of costs. Tables to assist with these calculations can be found in many cost-benefit or business algebra texts; see, for example, J.E. Kim's *Cost-Effectiveness/Benefit Analysis of Postsecondary Vocational Programs.* The formulas are:

$$\sum_{t=1}^{n} \frac{II(1+K)^{t-1}}{(1+r)^t} = C, \text{ or}$$

$$\sum_{t=1}^{n} \frac{(1+K)^{t-1}}{(1+r)^t} = \frac{C}{II}$$

where:

II = increased incomes

C (see NPV formula, this page)

Activity 10: Interpret the Results. When interpreting the results of your C-B-E study, you will find it helpful initially to look at the measures of effectiveness, efficiency and benefit separately. In choosing an alternative course of action on the basis of these three measures, you may wish either to: (1) weight the measures according to importance and choose the alternative with the highest total score, or (2) eliminate the weightings and simply choose the alternative with the highest total score.

Under some circumstances, there may be no need for all three measures in choosing alternative strategies for action. Efficiency measures can be obtained only through implementation either conducted by you or by some other program. In considering alternatives, none of which have been implemented with cost documentation, you must assume that budgeted unit cost equals actual unit cost, until actual practice demonstrates otherwise. If you decide that one or two of the measures are inappropriate for your purposes, choose the most appropriate measure and evaluate strategies on the basis of that measure.

Assuming that you will be using all three measures, the following guide is offered as a format for interpreting the results.

First, consider program effectiveness measures. Among the questions you should be able to answer are:

- How well (to what degree) will objectives/goals be achieved?

- Are objectives appropriate in light of strategies?
- Are program goals reasonable and appropriate in light of strategies?

Second, interpret cost-efficiency measures. Among the questions you will need to address are:

- Are all relevant cost elements included?
- Are costs prorated appropriately for the program(s) under study?
- Are selected efficiency measures valid indicators of program efficiency?

Third, analyze the cost-effectiveness (E-C) ratio(s). The alternative strategy with the highest E-C ratio is the one of choice, or more appropriately, the most "effective" alternative strategy for the money spent. If ratios are similar, you must consider other qualitative information such as:

- How administratively feasible is the strategy?
- What political forces may come into play to influence the degree of success of each strategy?
- Are well-trained staff equally available for carrying out the strategies?
- What are your impressions about the degree of staff acceptance of each strategy?

Fourth, consider performance ratios. Performance ratios provide a combined measure of strategy effectiveness and efficiency. The performance ratio answers the question: Which strategy is the most effective and efficient? The strategy of choice is that with the largest ratio.

Fifth, address several additional considerations. Specifically, when evaluating/comparing two or more strategies, it is necessary to consider the following:

- Were effectiveness scores, indices, and ratios based on the same target goals? If *not*, programs cannot meaningfully be compared.
- Were the same cost elements and methods of prorating common across all strategies compared? If *not*, programs cannot be compared.
- Were the characteristics of students in the strategies compared roughly similar? If *not*, the study's outcomes could as easily have been a result of student differences as strategy differences.

Sixth, interpret cost-benefit (C-B) measures. As you may recall, three measures of cost-benefit were calculated: net present value, B/C ratios and internal rate of return.

- Net present value (of increased incomes). The size of the figure indicates the difference between costs and benefits. The strategy with the largest net present value is the most desirable, in terms of this measure. This measure is the preferred method of C-B-E analysts.
- B/C ratio. This ratio provides an indication of the extent to which benefits exceed—or fail to exceed—costs. The strategy with the largest B/C ratio ranks most favorably on this measure.
- Internal rate of return. This measure indicates the extent to which benefits exceed the interest rate. The strategy with the largest internal rate of return ranks most favorably on this measure.

Review the last four activities (6-10) in the C-B-E study implementation process and check your understanding by filling in the missing blanks in the statements listed below. The terms to be used are listed first to help jog your memory on this one.

performance ratio	effectiveness
efficiency	internal rate of return
B/C ratio	E-C ratio

1. This ratio provides an indication of the extent to which benefits exceed—or fail to exceed—costs. The strategy with the largest _____ ranks most favorably on this measure.
2. The average program effectiveness index divided by the unit cost is the computation procedure for the _____.
3. The _____ provides a combined measure of strategy effectiveness and efficiency.
4. Cost _____ expresses the relationship between cost and units of output. It is an evaluation of the adequacy of program management.
5. The measure of _____ indicates the extent to which benefits exceed the interest rate.
6. When interpreting the results of a C-B-E study, it is helpful to look at measures of _____, efficiency and benefit separately.

Answers:
1. B/C ratio 2. E-C ratio 3. performance ratio 4. efficiency 5. internal rate of return 6. effectiveness

Activity 11: Develop Conclusions. When comparing programs, you should be able, on the basis of the information developed in Activity 10, to answer the following questions as an outline for your conclusions:

- Which strategy is the most effective?
- Which strategy is the most efficient?
- Which strategy is the most effective and efficient?
- Rank order the strategies in terms of their degree of desirability and justify the rankings with concrete data. (The justification should be written later in a form that lay people can understand.)

Activity 12: Develop Recommendations and Report Conclusions. Based on the data you have accumulated thus far, you should have some recommendations for future action, depending on the purposes and intended uses of your study results. Remember to consider how strategies could be made more efficient and effective and what additional resources could be used in strategy implementation. When reporting your conclusions, remember to relate barriers, goals, objectives, strategies, resources and outcomes in offering your justification for selecting certain strategies.

Activity 13: Utilize and Apply Results. Remember that the analyses you have performed on alternative strategies have multiple uses. Not only can the data be used for program planning and for making resource allocation decisions, but also for designing program evaluation.

Other considerations. Some problems you may encounter when implementing a C-B-E comparison include difficulties because of time, resources, differences of opinions, and inadequate information. A C-B-E study of the scope described here could probably be completed in two months; however, the effort required would be major. Stretching the study out over several more months should allow sufficient time without undue burden, provided that adequate staff are available. In spite of this, time will still likely be a constraint. If, as you plan the comparison, a realistic yet fairly rigid time schedule is developed, many of the typical time constraints will be eliminated. Other means of avoiding long delays in meeting time schedules include close monitoring and checking with those who have task responsibilities. Even more basic, choose study team members carefully and try to include those people who have a commitment to making the study a successful one. It will also be necessary to devote some effort to team building, especially in the beginning, and continue the team focus throughout the course of the comparison.

As you are aware, a C-B-E study is not only a device for strategy comparison and selection but also can serve other purposes such as evaluation, program planning and program development. When viewed as a multi-purpose tool, and costs are distributed accordingly, such a comparison is less costly than it might otherwise appear.

If you have a shortage of qualified personnel, it may be necessary for you to hire a technical specialist on a part-time or consultant basis. Try to resist the urge to hire someone outside the school system to conduct the entire study. The probability that the results of the study will have an impact will increase proportionately with the degree of involvement of those who will be affected by the study. Thus, try to involve school staff in the planning and implementation of the study whenever possible rather than hiring an outsider to assume total responsibility.

Differences of opinion about goals and objectives should not be a great problem if Steps 1, 2 and 3 were conducted thoroughly in the Planning System. However, when several people, particularly those who have not been involved in the accessibility planning at an earlier stage, are involved in the development of strategy goals and objectives, arriving at a consensus is often a difficult task. Legislating or imposing a set of goals and objectives or designating an "expert" to develop them usually only side-steps the issues temporarily. Eventually objections show up in other ways such as team demoralization, missed meetings and deadlines, and inferior work. One strategy for coping with this issue is to employ a group decision-making technique such as the Nominal Group Technique to produce ranked alternative objectives for the group.

The greatest information deficit that plagues school systems is lack of adequate cost data. Much information is available in the school's accounting records; however, other data must be estimated without a frame of reference. Estimating the cost of equipment and structural modifications especially can be difficult if the educational unit has not undertaken such efforts before and thus has no record of the cost of such modifications. You may wish to call in a cost analyst to perform the cost analysis segment of the C-B-E study. Also, it is often possible to contact other educational units which have made similar modifications and use their figures as a base. If figures are over a year old, you will have to adjust for inflation.

Some educational units have estimated student baseline measures using data from other educational units that have students with characteristics similar to their own. While such data may be better than no data, it is risky to assume that students from different schools are similar enough to make it possible to use their personal data interchangeably. Unless it is absolutely impossible to do so, collect projected outcome measures from your own population based on past performance.

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1. In conducting a C-B-E study, use of outside consultants or technical specialists is encouraged. In fact, they should be allowed to do as much as possible, True or False?

2. One of the most likely problems you will encounter in conducting a C-B-E study is lack of adequate cost data. True or False?

3. A C-B-E study can usually be completed in a matter of several (a) weeks? (b) months? (c) years?

4. A good C-B-E study is usally carried out by: (a) a team of persons committed to the project who have educational responsibilities or ties with the school; (b) an outside expert, working alone, who knows exactly what to do and simply needs information with which to work.

Answers:
1. False 2. True 3. months 4. (a) team.

ADDITIONAL RESOURCES

You are encouraged to consult the following studies and articles as you implement a C-B-E comparison study. A brief annotation is noted with each reference.

Blaugh, Mark. *An Introduction to the Economics of Education.* London: Allen Lane and Penguin Press, 1970.

This is a general survey of cost-benefit analysis as it applies to education. It is a good reference for some of the theoretical underpinnings and considerations of C-B analysis as they apply (or fail to apply) to education.

Fielden, John. The cost of innovation and change in education. *Programmed Learning and Educational Technology.* Vol. 15(1), February 1978.

This is a good, basic article on costing and cost analysis.

Fisher, G.H. *Cost Considerations in Systems Analysis.* New York: American Elsevier Publishers, 1970.

This is an excellent reference on costing and categories of cost. Examples relate primarily to the military and other branches of Federal government but may be easily adapted to the school environment. It contains an especially good treatment of how to choose a discount rate and how to cope with uncertainty in C-B-E-type studies.

Franklin, Gerald, and William E. Sparkman. The cost-effectiveness of two program delivery systems for exceptional children. *Journal of Education Finance.* Vol. 3(3), Winter 1978.

The authors examine the cost-effectiveness of two instructional modalities for exceptional children: resource room versus the self-contained classroom. The description of the methodology is especially useful.

Kim, Jin Eun. *A Cost-Effectiveness/ Benefit Analysis Model for Postsecondary Vocational Programs.* Indiana: State Board of Vocational and Technical Education, October 1977.

The model which served as the basis for the study example is particularly applicable to C-B-E studies of vocational education but is easily adaptable to other program alternatives. The technical report includes an appendix filled with sample data forms and tables to assist with computations. The Administrator's Manual is a simple step-by-step, how-to guide that sometimes leaves gaps, especially in interpretation and application of results.

Webb, Lillian Dean. Cost-benefit analysis: an accountability device. *Journal of Education Finance.* Vol. 2(2), 1976.

This article details the methodology of a cost-benefit study in an educational setting and offers challenging strategies for presentations to the public with cost-benefit data as convincing evidence.

Wolfe, Barbara. A cost-effectiveness analysis of reductions in school expenditures: an application of an educational production function. *Journal of Education Finance. Vol. 2,* Spring 1977.

This article includes interesting cost-containment strategies tied to outcome measures. It makes a good case for the argument that you can cut program costs without decreasing effectiveness and tells how.

Decision Trees

Most administrators, in attempting to solve a problem or make a decision on some issue, have a reflexive tendency to cut it down to size and remove all but the bare essential information about it. Such a tendency is understandable given the difficulty in processing large amounts of information. It is unfortunate that decision-making often occurs in this way since problems are rarely this uncomplicated. One decision often affects and is affected by a series of subsequent decisions. That knowledge alone should influence the nature of the initial decision, but because of time and physical limitations, decisions continue to be made as though they were isolated from each other.

A Decision Tree is a graphic representation of a series of alternative decisions about a strategy or strategies that will help you clarify choices and risks by projecting alternative outcomes, costs and payoffs of different strategies. The technique assists you to examine the multi-faceted effects of selecting particular strategies for barrier removal.

Alternative strategies and subsequent decisions are displayed graphically, beginning at the left-hand side of the page. The point at which a decision is to be made, a *decision point*, is depicted by a square. At this point, a finite number of alternative courses of action are presented and shown as *branches* emerging to the right side of the decision point. Where it is possible to do so, a cost associated with the decision may be displayed along the branch of each alternative.

In addition to decision points, *chance points*, designated by a circle, are displayed to signify the anticipation of the occurrence of one of the finite states of nature. These are displayed to the right of the decision points. Branches may also emerge from chance points and on these branches an estimated probability of occurrence of the chance event may be presented.

The construction of a Decision Tree produces a list of decision alternatives and probable outcomes of each decision for a strategy or set of strategies for barrier removal. Depending on the nature of the problem, the user also may have probabilities and costs associated with each outcome displayed graphically for easy information access.

See if you can answer the following questions about Decision Trees before continuing.

Decision trees are useful when: (check one)

a. There are multiple decisions to consider.
b. One decision influences and is influenced by several other decisions.
c. A decision can be isolated from other elements in the situation.
d. You are interested in considering the possible effects of several decisions on each other.
e. Both a and b.
f. Both c and d.

A branch is a line for projecting from: (check one)

a. A decision point
b. A chance point
c. A cost projection
d. Both a and b
e. Both b and c

A decision point is depicted as a square on the Decision Tree whereas a chance point is displayed as a (Fill in the blank.)

Branches project to the (left, right). (Circle one.)

Answers:
e; d; circle; right.

STRENGTHS AND LIMITATIONS OF DECISION TREES

One of the most useful aspects of Decision Trees is that they allow the presentation and consideration at one time of a number of alternative decisions about single strategies or groups of strategies. Even more important is the effect on perception for you and the LPC that this presentation stimulates. Decisions do not occur in isolation in spite of the fact that it is simpler and less taxing to consider them in that way. Decision Tree methodology forces the decision-maker to view the impact of a decision on others and to see the environment as a whole rather than an entity composed of isolated elements. The technique also can serve as a forecasting device when appropriate time parameters are included in the display.

The most critical limitation of Decision Trees is that the nature of the methodology requires that the number of alternative decisions be finite and, by necessity, small in number for each suggested strategy. There is always the risk that important alternatives may be omitted by the decision-maker in the construction of the tree. In that sense, as is true with most decision-making devices, the technique is only as good as the information that is fed into it.

WHEN SHOULD DECISION TREES BE USED?

Decision Trees should be used when a decision-maker is faced with a decision about a strategy whose outcome affects and will be affected by several other decisions. In order for the technique to be effective, the user should know or be able to find out:

- What alternative steps within each strategy are available;
- What the probable outcomes of each alternative step are; and
- What variables influence the occurrence of these outcomes.

Although not essential, it would be helpful if the user had some knowledge as to the cost of various alternatives and the probability of occurrence of various outcomes.

When should Decision Trees be used?

Answer:
When the outcomes of a decision about particular strategies will affect and be affected by several other decisions.

RESOURCES AND MATERIALS REQUIRED

The effort required to construct a Decision Tree will depend largely on the size and complexity of the strategies to be compared. For relatively restricted strategies or a small number of strategies, the time requirement is small—no more than a day if the user has a fair grasp of the nature of each strategy and the critical variables involved. Large and more complex strategies, or larger numbers of alternative strategies, may require two persons' time for a week. Although one person can construct a tree, it is often helpful to seek the assistance of others in defining the nature of the problem, specifying alternatives and estimating probable outcomes and costs.

No special materials are required to construct a Decision Tree other than pencils, paper and a ruler. A calculator would be helpful if costs and probability estimates are included. When the number of strategies and decisions within strategies are small, all computations may be done by hand. For extremely large and complex problems, however, it is necessary to use a computer. For many purposes, quantitative information may be omitted entirely, thereby eliminating the necessity of arriving at estimated costs and probabilities of occurrence.

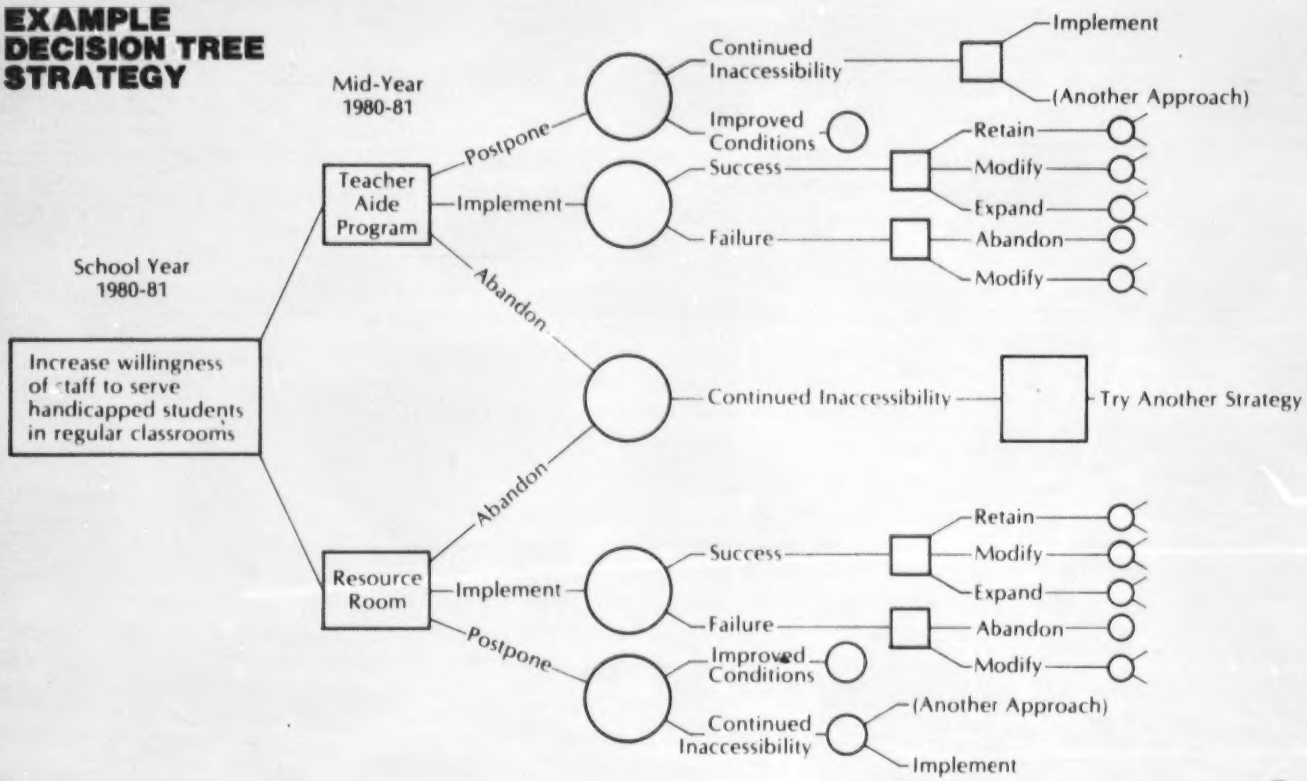
HOW TO IMPLEMENT DECISION TREES

Before beginning the construction of your Decision Tree, state your objectives clearly and thoroughly. Also review and state each strategy generated in Step 3 clearly and precisely, particularly as it relates to each objective. By doing this, you will have a clearer idea of the function you wish your tree to serve and some of the elements it should contain.

Activity 1: Identify Your Initial Decision Point. Begin the construction of your tree at the far left side of your paper with the initial decision—the goal or objective to address—depicted as a square. A sample Decision Tree is depicted on the next page; notice in the example that the initial goal or objective is to increase the willingness of staff to serve handicapped students in regular vocational programs. The decision is displayed in the square at the far left side of the page.

Activity 2: List All Possible Strategies. Alternative strategies to achieve the goal should be displayed as lines or branches projecting from the decision point you identified in Activity 1. Refer again to the sample Decision Tree; you will notice that there are two possible alternative activities identified: to create an instructional aide program or to develop a resource room. In your situation, the alternative strategies may be very different.

EXAMPLE DECISION TREE STRATEGY



Activity 3: List All Possible Alternative Courses of Action for Each Strategy. These will be displayed as lines or branches projecting from the decision points you identified in Activity 2. Refer again to the sample. Here there are three possible alternatives identified: to implement, postpone or abandon entirely. In your situation, the alternatives may be very different. Suppose, for example, that your tree is concerned with the decision to make your electronics program accessible. Suppose further that you cannot abandon the decision for to do so would invite legal complications that you have chosen to avoid. You may have the option of postponing the decision, if only for a few months. In this situation you have two options for each suggested strategy: to implement or postpone.

Activity 4: List Chance Points (or decision points) and Possible Outcomes. Recall that chance points indicate possible outcomes of the decision alternatives within each strategy. Consider the alternative action, "Abandon," in the example. The possible outcomes projecting from this chance point are high student failure or improved student performance. The same is true regarding the decision alternative, "Postpone." The outcomes for "Implement" are that the individualized approach may succeed or fail. If student performance improves or if the individualized approach is successful, no further decisions are considered. If the approach fails or if student failure rate is high, several other decision alternatives emerge.

Activity 5: Include a Time Dimension. One strength of Decision Tree as a comparison technique is that it allows projections over time. The decisions displayed in the sample tree cover a two-year time period. If you are including time periods, the first will normally occur at the first set of chance points as in the example. The second will occur at the second set, and so on.

You may also wish to include time estimates for the various decision alternatives that you generate for each strategy. In the example you can estimate how long the "Implement" alternative would require in the first set of decision alternatives. In the second set in the example, you can estimate the time requirements for "implement," "try another method," "modify present method."

Activity 6: Include Cost Projections. As was true for the time estimates, you may, if appropriate and helpful for you to do so, include cost estimates for the various alternatives. In the example, you could estimate the costs of "implement," "postpone," "abandon," "modify," and so on. Estimates of cost should be placed above or below the appropriate branch so that all information is visible and available to you as you need it.

1. The six steps involved in constructing a Decision Tree are listed below. Place them in their correct sequence by numbering 1, 2, 3, 4, 5, or 6 beside each step.

____ list chance (decision) points and possible outcomes
____ include a time dimension
____ list all possible strategies
____ include cost projections
____ identify your initial decision point
____ list all possible alternative courses of action for each strategy

2. For many purposes, a Decision Tree may be used without quantitative information. True or False?

3. One of the major benefits of the Decision Tree approach is that it aids the administrator in seeing both short-term and long-term implications of strategy implementation. True or False?

Answers:
1. The proper sequence is 4, 5, 2, 6, 1, and 3.
2. True
3. True

ADDITIONAL CONSIDERATIONS

Depending on the nature of your tree, you may wish to estimate the probability of occurrence of each of the chance events. This is common practice in business and industry but variables in educational settings are much harder to predict. If you can generate probabilities of occurrence with some confidence in their accuracy, include them on the tree above or below the appropriate branches.

In making the final decision on comparing strategies you may find it helpful to identify possible "payoffs" or benefits of each decision alternative. This should not be the only dimension you consider, however. Your final decision should take into account these elements within each strategy to be compared:

- Outcomes;
- Risks associated with each alternative (including likelihood of occurrence of each outcome);
- Costs associated with each alternative;
- Resources available; and
- Feasibility of implementation.

Your final decision will often evolve from your answer to the question, "How much risk am I willing or able to accept in order to achieve a particular outcome?"

ADDITIONAL RESOURCES

You will find these sources helpful in constructing your Decision Tree.

Finch, Curtis R., and John R. Crunkilton. *Curriculum Development in Vocational and Technical Education.* Boston: Allyn & Bacon, Inc., 1979.

This volume includes several examples of Decision Trees is one of which is concerned with a vocational education situation. The accompanying discussion is brief but informative.

Turban, Efriam, and Jack R. Meredith. *Fundamentals of Management Science.* Dallas, Texas: Business Publications, Inc., 1977.

Although the examples apply almost exclusively to business and industry, the procedures for tree construction are applicable to users in all situations. Directions for calculating probabilities and cost are also included.

Simulation

Simulation may be defined as a representation of a real-life situation in terms of its most essential elements and characteristics. In a Simulation, participants take on roles which represent real world conflicts or problems and make decisions in response to their assessment of the setting. Participants experience simulated consequences which relate to their decisions and general performance; afterwards they can monitor results and ponder the relation between their decisions and the consequences. Role-playing, games, computer Simulations are various kinds of Simulations, but only Computer Simulations are discussed in this booklet.

Computer models have been developed primarily by engineers and mathematicians to simulate highly technical, complex problems. Computer Simulations are very powerful because probability estimates and random events may be built into the models and the limits of time and strength of materials tested. Computer Simulations are *most* appropriate for finding very specific "answers" to technical questions and have less often been applied to problems with human elements such as attitudes and values.

It is surprising that more problem-solving simulations are not available in educational units since the hardware is available in most systems. Computer models are presently used in schools to schedule students, to handle payrolls, and to keep track of personnel. With few modifications, these models could assist with planning (Pograw, 1978). It is because of anticipated high costs that Computer Simulations have been seldom used in educational decision-making.

Unfortunately, up until now quantitative techniques in educational administration have possessed limited ability to solve planning problems or have been used only in an artificial manner. The classical model of decision-making and planning requires that administrators choose from among a set of alternatives the one alternative which produces optimal benefits relative to costs. Techniques available to help administrators project the possible effects of alternative strategies under existing or possible future circumstances have assumed static circumstances and too often allow only one decision to be made at a time.

As educational planning has become more complex and future-oriented, the limitations of older techniques have become more apparent. Computer Simulations can handle the complexity of planning problems, and the costs of such applications are decreasing. Sophisticated and easy to use computer languages such as GPSS, SPSS, BASIC and PLI have been developed recently and facilitate computer application.

1. What can Computer Simulations do that other comparison techniques do not do as efficiently?
   a. quantify human values and attitudes
   b. estimate probabilities of occurrence
   c. figure costs exactly
   d. rank-order items in a list
   e. build in random events or outcomes

2. Why have Computer Simulations not been used as extensively for educational planning as they have been in business and industry?

_____

_____

3. Give two reasons why educational planners should consider computer models.

1) _____

2) _____

Answers:
1. b & e; 2. Administrators think they will be expensive; 3. (a) Other methods have failed (b) educational problems are becoming more complex (c) using computer is becoming easier and (d) computer costs are decreasing.

A variety of Computer Simulations are available such as "fault tree" analysis, decision trees, and systems analysis. All these methods have in common the development of a computer model analogous to the real educational situation, a school's accounting procedures, for example. Once the model is developed, various initial figures may be submitted to find out what would happen under different circumstances. An individual or group may decide on the initial figures, though the Local Planning Committee is suggested for use with the problem at hand.

STRENGTHS AND LIMITATIONS OF SIMULATION

Computer simulations offer some important advantages over the other suggested methods for comparing strategies. With them the school administrator can be advised about a wider range of possible outcomes of various strategies. With Simulations, several actions may be considered simultaneously, whereas with other techniques you can proceed only event by event. The Simulation model can be as complicated or as simple as is possible or necessary. With a computer, the user may experiment with situations which the school could not actually allow to develop in practice, allowing equipment to wear out, for example.

With the Simulation technique, several different variables may be simultaneously manipulated and the results obtained almost instantly, once the model has been "debugged." When more options are considered, the quality of the decisions may be improved (Pograw, 1978). The technique may be applied to a variety of planning problems other than vocational education for handicapped students for which the method is generally applicable. Computer Simulations have been used to explore the economic, social and political environment of Europe during 1970-1980, alternative futures for American education, urbanization of Europe 1979-1985 and the social, political and environmental future of Canada (Brauers, 1976).

Computer Simulations have several potential drawbacks, the major one of which is the adequacy of the model which is developed. However complex the strategy being investigated, the data generated and decision made on the basis of the Simulation are only as good as the

original program or algorithm. The Simulation may or may not be valid depending upon how much information and effort goes into development, how well changes over time are anticipated, and what limits are built into the program such as the number of variables that may be entered.

The other limitations of Simulation techniques are varied. Perhaps most important, at present, Simulations are best suited to issues like space needs, costs, equipment needs, utilization and so forth. Projecting outcomes of strategies designed to address attitude and policy barriers by using current programs is much more difficult and costly because of required modifications.

Other limitations do exist. For example, the initial costs of development can be quite high. Human error in entering data or in interpreting results also may occur. Because computers are so fast and efficient, users, particularly those with limited computer experience, sometimes begin to believe the results are infallible; since many problems with a computer model only become apparent after its continued use, disillusion can follow. A final danger with Simulations is that the decision-making process may become an individual effort even though group involvement and decision-making is really necessary for the recommendations obtained with the aid of a computer to be widely supported within the organization.

1. Which of the following is not an advantage of Computer Simulations over other methods of group decision-making?
   a. all possible outcomes are generated
   b. events may occur simultaneously rather than sequentially
   c. several variables may be changed at the same time
   d. allow people to voice their feelings and frustrations
   e. may be used with other problems and planning

2. What is the major reason to be skeptical or computer simulation models? _____

Answers:
1. d; 2. The Simulation is only as good as the original problem or model. If it was not written general enough or in enough detail, the outcomes generated will be useless.

WHEN SHOULD SIMULATION BE USED?

The most critical questions to consider in deciding whether to use a Computer Simulation technique or some other method are "How complicated is the strategy under consideration" and "are there more than two or three strategies to consider?" The larger and more complex the educational unit and the proposed strategies, the more likely the problem is to be suitable for Computer Simulations. Also, a larger school system is more likely to have computer facilities and programmers already available to assist with developing a model or adapting one developed elsewhere.

Altogether, several circumstances warrant the use of Simulation. techniques. When it is necessary to consider several or all variables of the problem simultaneously, simulation is appropriate. If, given certain pre-conditions, you want to know the probability of an event occurring in order to improve decision-making, Simulation techniques could be considered. Another appropriate situation for Simulation use would be an instance when a number of problems could be solved using one procedure, thus reducing the money required for the initial investment. In contexts other than education, Simulations are often used simply because a computer is there and not because these other conditions have been met. This misapplication has not helped clarify when simulation is the most appropriate technique.

RESOURCES AND MATERIALS REQUIRED

If an educational unit has already contracted time on a computer for the school year, the use of a small amount of that time for installing a Computer Simultion to be used for several planning purposes would not be very large. Actually, running the program would take a few minutes, and the cost of computers per minute is decreasing. Also, if the computer program could be used for other kinds of planning, the cost would be defrayed among several different program efforts. However, if a school system has no computer history, it would be best to investigate one of the other suggested methods for identifying ways of overcoming barriers.

The materials required for Computer Simulation already have been mentioned. A computer and programmer to translate the decision-makers' statements into the language the machine uses are the primary needs. The Local Planning Committee must work together to specify the problems and options, possibly rank-order options, and discuss the projections the computer makes. The LPC meeting could occupy an entire morning, including running the program, or it could be broken into two short meetings on different days, one to discuss alternative strategies and one to discuss the outcomes generated by the computer.

1. What consideration is most important in deciding whether to use a Computer Simulation? _____

2. What do you need in order to run a Computer Simulation?

_____

3. How would you rate the cost of using this method, assuming your educational unit already used computer facilities to schedule classes and figure payrolls?

Very Cheap	Slightly Cheap	Moderate Cost	Somewhat Expensive	Very Expensive

Answers:
1. How complex the problem of making vocational education available to handicapped students is.
2. Computer time and programmer. 3. Probably "moderate" or toward "somewhat expensive."

HOW TO CONDUCT A SIMULATION SESSION

One Adaptation: Simu-School. The most recent and practical application of computers to the problem of planning in education is Simu-School (Winfield, 1979). In this model computers are used to forecast outcomes of different proposed strategies or solutions to problems so that educators and lay people who help them can choose more wisely among the optionas available. Developed over the last eight years by the Dallas Independent School District under a grant from the U.S. Office of Education, the Simu-School computer model is now available to local school districts through state National Diffusion Network (NDN) facilitators.

The Simu-School package includes three different programs. The first model requires current enrollment figures and rates of growth and predicts enrollment, number of facilities, and kinds of programs that will be needed. The second model indicates faculty requirements at different schools in light of population trends. The third program computes how much it will cost, though this last program is the most difficult to "borrow," since funding formulas are so exact and vary so much from place to place.

Two important questions about the Simu-School program are "How much does it cost?" and "Where can

it be found?" The cost of adapting the program to a standard computer would be small, and for those systems which use smaller machines, the model is being changed to fit mini-computers which most systems use. Through the state NDN facilitator, a school system can receive $6000 or more to install the system and to hire technical assistance. In addition to Texas, the program is available in Ohio, Washington, Minnesota, New York and New Hampshire.

1. Who developed the Simu-School computer model?
   a. IBM
   b. a university education department
   c. school people
   d. parent advisory group
   e. a computer programmer named Simu
2. What does the program do?
   a. predicts enrollment, kinds of programs, and number of facilities
   b. indicates staff requirements at each facility
   c. figures cost
   d. all of the above
   e. none of the above
3. How can a school administrator find out more about this Simu-School model?

Answers:
1. c; 2. d; 3. Contact the National Diffusion Network "facilitator" in their state Office of Education.

Procedures. The Simu-School model could be used best to compare certain types of strategies for barrier removal—if, for example, a Local Planning Committee wished to know the long-range effects of one of several strategies for removing barriers. Specifically, they wanted to know the effects of a special vocational program serving handicapped students at one school versus another. The computer could provide information helpful in choosing the better site by predicting population changes over the next five or ten years. The particular types of data produced would focus primarily on long-term administrative data and could include information on potential use of strategies at the proposed location, transportation costs with regard to alternative locations and required equipment and facility modifications at various locations. Such comparisons permit selection of a strategy as well as consideration of factors affecting strategy implementation.

The computer simulation functions in the following manner. Each event is matched with each other event in a matrix. Each entry in the matrix, generated by computer, shows the new likelihood of occurrence of event "b" if event "a" occurs. From the first matrix the computer derives a second matrix, each entry in which shows the likelihood of event "b" if event "a" does not occur. In a final operation the computer estimates final probabilities by simulating 1000 rounds of joint occurrences of each event. After considering events "a" and "b" it goes on to "b" and "c" until the list of options submitted is exhausted. When completed, the program usually selects the few strategies with the highest probabilities of occurrence and prints them out for the group to consider.

In order to use Simulation, you must have the strategies well specified and must have baseline and projected data about the variables such as population growth, incidence of handicapping conditions, costs, and so forth that you wish to consider. Simu-School can be adapted to project outcomes from such data. Specific directions for using and adapting Simu-School must be completed at the local level rather than in this booklet due to the great variance between the conditions, needs, and strategies of local educational units.

1. What kind of information does the Simu-School model provide?

2. What does the computer do quickly and accurately that would be difficult and time-consuming to do by hand?

a. figure means and medians
b. project future needs
c. think of all possible alternatives
d. put a price tag on "popular sentiment"
e. computes joint probabilities many times over

Answers:
1. School population over one or several years, needs for building and for teachers, cost estimates for different alternatives. 2. e.

One person can operate a computer simulation to compare alternative strategies for removing barriers, but it is important to involve those affected by decisions in the final selection process. The role of consumers, handicapped students, their parents, and teachers in the process will enhance the effectiveness of any strategy chosen. The group's reactions to whatever the computer projects is essential, for the option may prove politically unpopular for a number of reasons never previously discussed.

Computer simulations can significantly decrease the time required of participants in decision-making groups without removing from them control of the outcomes. Using a computer to simulate the time-consuming task of working-out long-range effects of different courses of action can noticeably shorten the time required for strategy comparison and selection. Further, because of the precision required to use the computer, the group's end results may well be more precise and clear than without computer assistance.

ADDITIONAL RESOURCES

Simulations have been available in business and industry for a number of years; this history is outlined by Brauers. For the most recent applications and evaluations of the technique the *Simulations/Gaming Journal* is a good resource. Cruickshank's new book, *First Book of Games and Simulation,* (1978) mentions some applications to problems in education, though it does not give many details of use.

How each school district might use Simu—School models will depend on local problems and facilities. For more information, please contact your state NDN officer or write Jane Richardson, Arthur Kramer School, 7131 Midbury Road, Dallas, Texas 75230. Information on Simu-School is also available from the U. S. Department of Education.

Concluding Activity

Now that you have completed reading the discussion of the two techniques you considered to be most applicable to your situation, please return to your Planning Record and enter the names of the technique you will use to conduct this step of the Planning System. You should then continue reading in the *Guide* with Step 5, ***Removing Barriers***

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